Software to Complement HTI's Model 240 Split-Beam Echosounder: A User's Guide to *HAFU* (Hydro-Acoustic File Utilities) and *QTS* (Qualark Tools for S-Plus).

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January 1995

Canadian Technical Report of Fisheries and Aquatic Sciences No. 2037

Fisheries and Oceans
Pêches et Océans
Canada

Canadian Technical Report of Fisheries and Aquatic Sciences

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Canadian Technical Report of
Fisheries and Aquatic Sciences 2037

1995

SOFTWARE TO COMPLEMENT HTI'S MODEL 240 SPLIT-BEAM ECHOSOUNDER: A USER'S GUIDE TO ***HAFU*** (HYDRO-ACOUSTIC FILE UTILITIES) AND ***QTS*** (QUALARK TOOLS FOR S-PLUS).

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Cat. No. Fs 97-6/2037E ISSN 0706-6457

Correct citation for this publication:

Olsen, N. 1995. Software to complement HTI's model 240 split-beam echosounder: A user's guide to *HAFU* (hydro-acoustic file utilities) and *QTS* (Qualark tools for S-Plus). Can. Tech. Rep. Fish. Aquat. Sci. 2037: 45p.

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CONVENTIONS USED IN THIS MANUAL

Words printed in bold, upper-case, fix-pitched typeface indicate commands or key-names that are typed into the computer exactly as written.
E.g.

`ESC` (The escape key)
`ENTER` (The enter key)
`HAFU` (The command "HAFU")

Words printed in upper-case, proportional typeface indicate data file types. These are always one of:

RAW
ECHO
FISH
SUMMARY
INTEGRATION

Words printed in upper-case, fix-pitched typeface indicate the names of directories on the hard drive.
E.g.

`\RESULTS`

Words printed in upper-case, bold-faced italics refer to the names of programs.
E.g.

HAFU
QTS
PKZIP

Phrases surrounded by quotations (" ") refer to specific menu items or data-entry prompts.
E.g.

"Convert HTI RAW files to PBS RAW file"
"Is this information correct (Y/N)?"

ABSTRACT

Olsen, N. 1995. Software to complement HTI's model 240 split-beam echosounder: A user's guide to *HAFU* (Hydro-Acoustic File Utilities) and *QTS* (Qualark Tools for S-Plus). Can. Tech. Rep. Fish. Aquat. Sci. 2037: 45p.

Hydroacoustic Technology Inc.'s (HTI) model 240 split-beam echosounder represents the state-of-the-art in split-beam hydroacoustic technology. The split-beam technique provides several advantages over traditional echosounder design, including the ability to accurately estimate target strength, and the ability to track and enumerate salmon as they migrate upstream to their spawning grounds. We have been using this system extensively since 1993 at a site near Qualark Creek on the Fraser River, just north of Hope, British Columbia, Canada. During this time we have developed several software packages to help us deal with the large volume of data produced by the system, and to aid us in analyzing and processing these data. The software is grouped into two categories; file management utilities, including utilities to compress, concatenate, and convert HTI data files, and data analysis routines, focusing primarily on graphical representations of the data. These categories are presented here as ***HAFU*** (Hydro-Acoustic File Utilities) and ***QTS*** (Qualark Tools for S-Plus), respectively. ***HAFU*** is a DOS program and requires no special hardware or software to run. ***QTS*** is written for S-Plus for Windows and therefore requires Windows 3.1 and S-Plus for Windows. A floppy disk containing the software discussed in this document can be obtained from us, free of charge.

RÉSUMÉ

Olsen, N. 1995. Software to complement HTI's model 240 split-beam echosounder: A user's guide to *HAFU* (Hydro-Acoustic File Utilities) and *QTS* (Qualark Tools for S-Plus). Can. Tech. Rep. Fish. Aquat. Sci. 2037: 45p.

L'échosondeur à faisceau divisé modèle 240 de l'Hydroacoustic Technology Inc. (HTI) est l'appareil à la fine pointe de la technologie en matière d'hydroacoustique à faisceau divisé. Les appareils à faisceau divisé présentent plusieurs avantages par rapport aux échosondeurs classiques dont la possibilité d'estimation précise de l'intensité des cibles et des possibilités de repérage et d'énumération des saumons migrant vers l'amont jusqu'à leur frayère. Nous avons abondamment utilisé ce système depuis 1993 à un emplacement situé sur le Fraser près du ruisseau Qualark juste au nord de Hope, (Colombie-Britannique) au Canada. Pendant cet intervalle, nous avons mis au point plusieurs progiciels facilitant la manipulation des imposants volumes de données produits par le système ainsi que l'analyse et le traitement de ces données. Les logiciels sont regroupés en deux catégories : des utilitaires de gestion de fichiers, incluant des utilitaires de compression, de concaténation et de conversion de fichiers de données HTI et des sous-programmes d'analyse de données axés principalement sur la représentation graphique de ces données. Ces deux catégories sont ici respectivement désignées par les acronymes ***HAFU*** (Hydro-Acoustic File Utilities) et ***QTS*** (Qualark Tools for S-Plus). Le ***HAFU*** est un programme DOS et son exécution n'exige aucun matériel ou logiciel spécial. Le ***QTS*** est écrit pour le S-Plus pour Windows et son exécution exige donc le S-Plus et le Windows 3.1. Nous fournissons sans frais une disquette comportant les logiciels ici présentés.

INTRODUCTION

This report is a user's manual for a set of software tools designed to complement *HTI's model 240 split-beam digital echo sounding system. Two packages are covered in this manual, a DOS-based set of file management utilities called ***HAFU*** (Hydro-Acoustic File Utilities), and a Windows-based set of S-Plus routines called ***QTS*** (Qualark Tools for S-Plus). Both sets of software are accessible from a menu system that runs from within S-Plus for Windows and, additionally, ***HAFU*** can be accessed as a stand-alone DOS program.

HTI'S SPLIT-BEAM ECHOSOUNDING SYSTEM.

HTI's Model 240, 200 KHz Split Beam Hydroacoustic System consists of a split-beam echosounder, a monitor and keyboard, two transducers, an oscilloscope, a chart recorder, a digital audio tape recorder, a 486DX personal computer, and a 24-pin dot-matrix computer printer (Fig. 1).

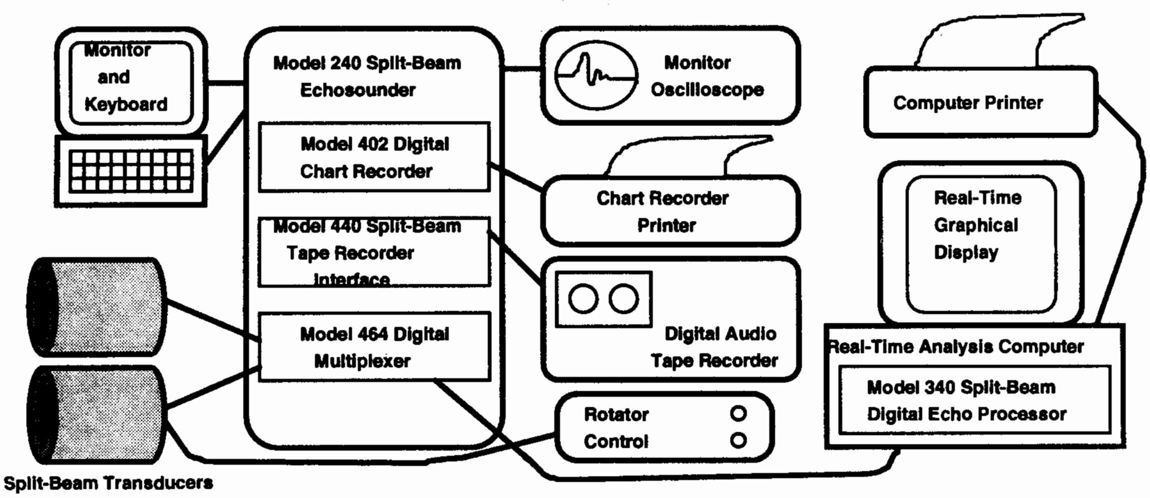

Fig. 1: Schematic diagram of HTI's model 240 split-beam hydroacoustic system as configured at Qualark. (From HTI, 1993).

Unlike conventional echosounders that can only determine the range of a target, a split beam echosounder can measure the three-dimensional position of a target. Therefore, it is possible to accurately track and enumerate fish as they migrate through the echosounder beam. The receiver contained in the split-beam echosounder provides simultaneous 20 log(R) and 40 log(R) time-varied-gain (TVG) output, so echo-integration and target tracking can be accomplished concurrently.

The digital split-beam processor (DSBP) board processes signals received from the split-beam echosounder. This board interfaces with the 486 computer attached

* Hydroacoustic Technology Inc., Seattle Washington, USA.

to the echosounder, via a standard ISA slot. The 486 computer also runs HTI's real-time software and stores data files collected during echosounding.

The digital chart recorder located in the echosounder prints echograms using a standard 24-pin dot-matrix printer. Echogram printing is controlled through a menu system accessible via the keyboard and monitor attached to the echosounder. The keyboard is also used to input various echosounder settings such as time-varied-gain, and ping rate.

The digital audio tape (DAT) recorder records raw echosounder output on tape. If desired, tapes can later be re-processed through the DSBP using modified echosounder parameters.

The oscilloscope provides the primary feedback for aiming the acoustic beam. It displays the return signal voltage vs. time (in effect, the return signal strength vs. range).

The rotator control remotely actuates a rotator to which the transducers are attached. This allows positioning of the beam both vertically, with respect to the river bottom, and horizontally, in the up-stream or down-stream direction.

HTI'S SOFTWARE.

HTI provides real-time and post-processing software that reside on the 486 computer connected to the echosounder. Integral to this group of programs are *DSBP* which performs echo integration and *DSBPTRAK* which performs target tracking. These two programs multitask under the DesQView operating environment, processing output from the DSBP board and producing output in the form of ASCII data files and real-time graphical displays. A variety of graphs can be displayed while data are collected (Fig. 2).

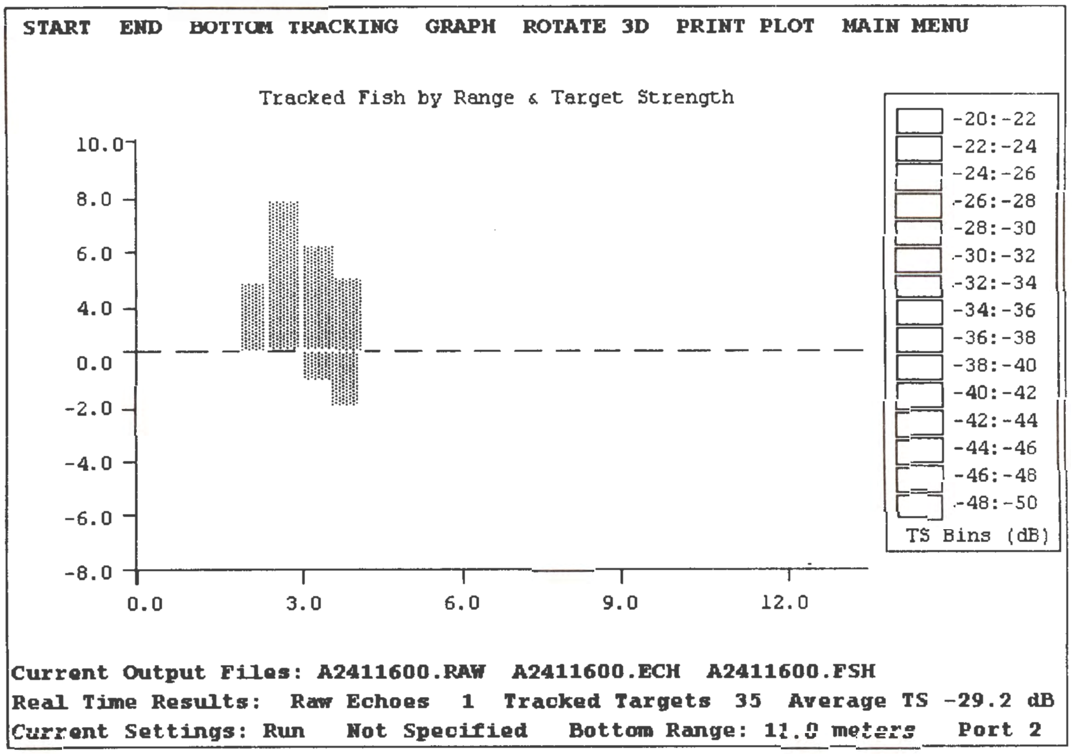

Fig. 2: Example on-screen display of HTI's DSBP software. Several real-time graphical displays are available. This one shows a histogram of tracked targets by range.

CHAPTER 1 - *HAFU*, THE HYDRO-ACOUSTIC FILE UTILITIES

A) OVERVIEW.

Although HTI's software is necessary for real-time data acquisition and analysis, we have found that their post-processing software is cumbersome to use with large volumes of data and often does not meet our requirements for detailed data analysis. Thus, we have developed our own software tools. These are grouped under two main categories: utilities to concatenate and convert HTI data files into a more useful format, and routines to analyze and graphically display the data.

The first category of software is accessible from the DOS program ***HAFU*** which is a menu-driven front end for several command-line utilities. A screen-display of ***HAFU*** is shown in Fig. 3.

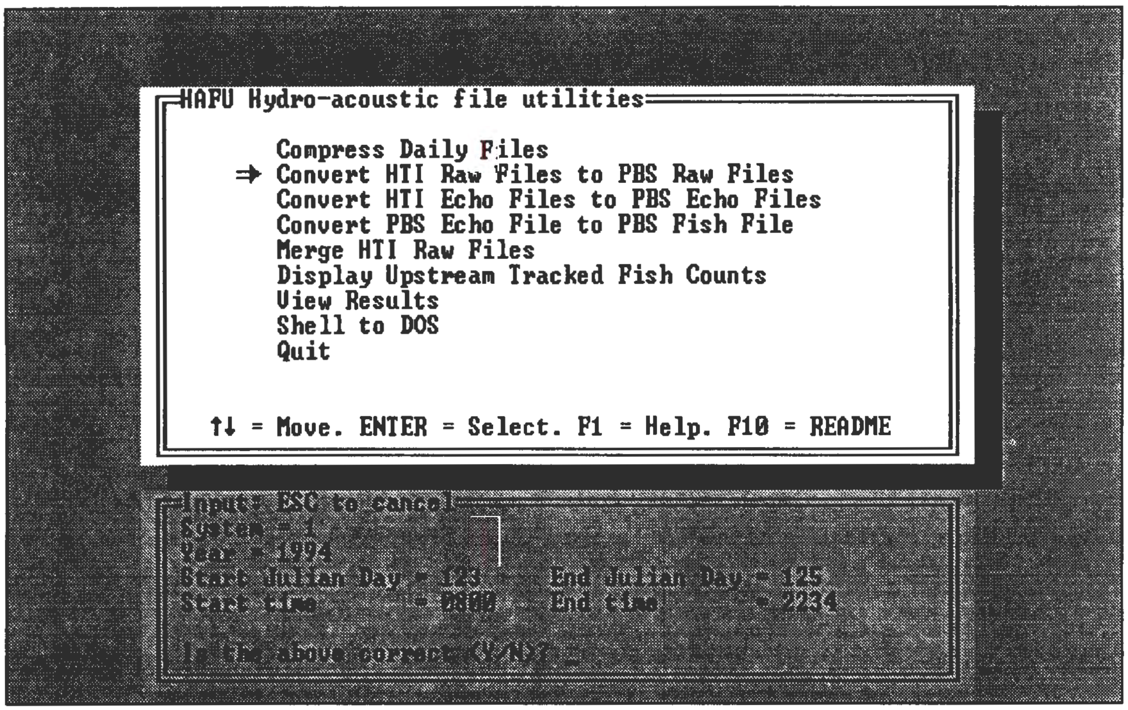

Fig. 3: Example on-screen display of *HAFU,* Hydro-Acoustic File Utilities.

The function of each ***HAFU*** menu item is outlined in Table 1.

Table 1. The function of each menu item in *HAFU*. Command arguments are shown in <brackets>.

Menu Item	User Input	Output	Command-Line Equivalent
Compress Daily Files.	Year and day of the year.	A PKZIP-format compressed file containing all data files for year and day.	`pkzip <zipfile> <datafiles>`
Convert HTI Raw Files to PBS Raw File.	Year, days of the year, and start and end times.	PBS-format raw file containing all HTI Raw file data for period specified.	`rawfiltr <HTIrawfile> <mux1output> <mux2output>`
Convert HTI Echo Files to PBS Echo File.	Year, days of the year, and start and end times.	PBS-format echo file containing all HTI Echo file data for period specified.	`echfiltr <HTIechofile> <mux1output> <mux2output>`
Convert PBS Echo File to PBS Fish File.	Name of PBS echo file.	PBS-format fish file containing conversion of specified PBS echo file.	`ech2fsh <echofile> <fishfile>`
Merge HTI Raw Files.	Year, days of the year, and start and end times.	HTI-format raw files split into output for each multiplexer port. New files are written each time a parameter change is encountered.	None.
[illegible]		NOT IMPLEMENTED	
View Results.	None	View output files from any of the above procedures. This item launches the shareware program called ***LIST***.	`list`
Shell to DOS.	None	Exits temporarily to DOS. Type 'exit' to return to ***HAFU***.	`command`
Quit.	None	Quits ***HAFU***.	`Not applicable.`

The primary value of ***HAFU*** is its ability to deal efficiently with large amounts of data from numerous files. For example, during an operational day at Qualark the echosounder may produce up to 120 separate data files (5 file-types x 24 hours) equaling on a low passage day, perhaps 10 megabytes of data. Using ***HAFU***, the user can compress all of these files into a single file approximately 10-30% of the original size. ***HAFU*** then operates from the compressed file, avoiding the need to decompress the files directly. For instance, if the user wishes to look at the raw data for a particular time frame, she needs to enter only the dates and times desired and the relevant files will be decompressed from the compressed file, converted to PBS-format, and concatenated into a single flat-file that can be read into a spreadsheet or other analysis software. Any intermediate stages between the compressed file and the PBS-format file are deleted during the process. Fig. 4 schematizes the operation of ***HAFU***. Refer to appendix A for a complete description of HTI and PBS file types and their formats.

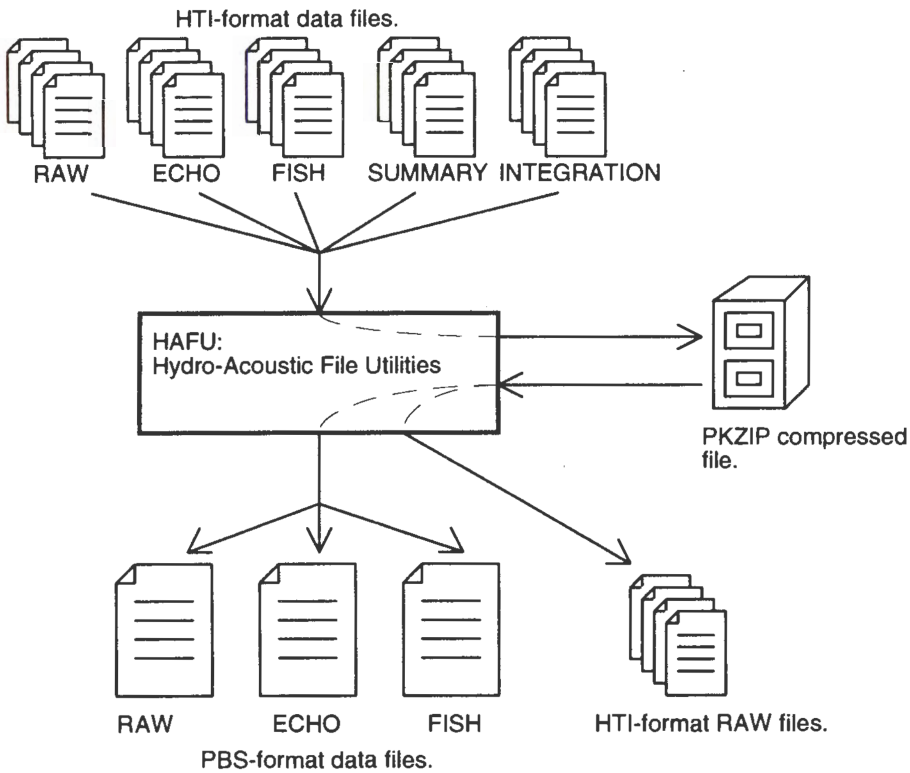

Fig. 4: Flow-diagram of *HAFU* 's operation.

B) *HAFU* USER'S MANUAL.

To begin a ***HAFU*** session, change to the directory containing the HTI data files you wish to analyze and enter **HAFU** at the DOS prompt. The program begins by creating two sub-directories under the current directory, one called `\RESULTS` and one called `\TEMP`, if they do not already exist. The `\RESULTS` directory stores PBS-format files resulting from any of ***HAFU***'s conversions of HTI files. The `\TEMP` directory is a temporary storage location for any HTI files that are extracted from a compressed file, and for intermediate files between HTI and PBS formats. You may delete the `\TEMP` directory after your ***HAFU*** session is completed. If you wish to delete the `\RESULTS` directory, first move the files you want to keep into an alternate directory.

B.1) Screen Elements.

B.1.1) The Main Menu.

The first menu displayed when ***HAFU*** starts is shown in Fig. 5. To select a menu item, use the up and down cursor control keys (⇧⇩) to position the menu-pointer (=>) next to the menu item of your choice and press **ENTER**.

```
HAFU Hydro-acoustic file utilities

    => Compress Daily Files
       Convert HTI RAW Files to PBS RAW File
       Convert HTI ECHO Files to PBS ECHO File
       Convert PBS ECHO File to PBS FISH File
       Merge HTI RAW Files
       Display Upstream Tracked Fish Counts
       View Results
       Shell to DOS
       Quit

  ↑↓ = Move. ENTER = Select. F1 = Help. F10 = README
```

Fig. 5: The main menu of *HAFU*. The menu-pointer is initially positioned next to the first item, "Compress Daily Files".

B.1.2) The Input Window.

Most of the menu items require that you enter certain information, usually the days and times of the period you wish to extract data for. This information is entered into the input window, shown in Fig. 6. The input window appears just below the main menu, after you select a menu item that requires input. If you wish to cancel the menu item that initiated the input window you must hit the **ESC** key first, before responding to any of the input prompts. This will return you to the main menu. Once you begin to enter your choices, hitting the **ESC** key will not cause the item to cancel. If you begin entering information and then later wish to cancel, continue entering information until you are prompted with the "Is the above correct (Y/N)?" prompt, then type **N** followed by **ESC**.

```
Input: ESC to cancel
Enter system (1/2): 1
Enter year (format=nnnn): 1994
Enter start julian day (format=nnn):
```

Fig. 6: The input window of *HAFU*. Information is entered line by line in response to the prompts displayed.

B.1.3) The Status Window.

The status window is designed to keep you informed of a specific task's progress, since certain tasks can take several minutes to complete. This window is also helpful for locating when and where a task fails, if an error is encountered. Fig. 7 shows the status window displaying a task in progress.

```
Status
Finished decompressing.
Processing, please wait ...
Done: A2380000.RAW => A2380000.SPR
                      B2380000.SPR
Done: A2380100.RAW => A2380100.SPR
                      B2380100.SPR
```

Fig. 7: The status window of *HAFU*. The progress of the task being performed is displayed in this window.

B.1.4) The Help Window.

The help window displays a brief description of each menu item. To view help on a particular menu item, position the menu-pointer next to the menu item and press the **F1** key. Fig. 8 shows the help window displaying help on the "Quit" menu item. To view a more detailed help file, press F10 while in the main menu.

```
Help - Press 'ESC' to clear
Quits HAFU and returns you to the operating system.
```

Fig. 8: The help window of *HAFU*. A brief description of each menu item is available via this window.

B.1.5) The Read Window.

HAFU uses the shareware program called ***LIST*** to display various ASCII files, including HTI and PBS data files. A full description of ***LIST***'s features are not included in this discussion. Refer to the ***LIST*** documentation in the `\HAFU\LIST` directory for more information regarding it's use.

B.2) Menu Items.

B.2.1) Compress Daily Files.

This menu item is used to compress all HTI files for a given day of a given year, into a single file. To begin this procedure, enter the number of the echosounder system, and the year and day that the HTI files were collected. The echosounder system number indicates which system the data were collected on. Currently it can only be **1** or **2** as an historical consequence of our use of two echosounders at Qualark. If you use only one echosounder system, the system number will always be **1**. If you use more than 2 systems, contact us to have your version of ***HAFU*** modified. The year must be entered as 4 digits, for example, **1995**. The day is defined as a sequence starting at 1 on January 1st of each year. It must be entered as 3 digits, for example **013** for January 13th. When you have finished entering all the required information, verify your entries by pressing **Y** after the "Is the above correct (Y/N)?" prompt. If you wish to change one or more of your entries press **N** after this prompt.

Once you have verified your entries, ***HAFU*** searches the current directory for all HTI files that match the system, year, and day that you specified, and compresses them using ***PKZIP***, into a single file. While this is happening the display switches to a plain DOS screen that allows you to view the compression as it occurs. When compression is complete the resulting file is checked for errors by ***PKUNZIP*** and the results are displayed on the screen. You can use the **Page Up** and **Page Down** keys to view these results and look for any compression errors that may have occurred. Each compressed file is listed down the left side of the screen with either an "OK" to the right of it or an error message (Fig. 9). Press **ESC** when you have finished viewing this information. The display then switches back to ***HAFU*** and you are asked if you wish to delete the original HTI files. Press **Y** if you are satisfied that the file compression operation was successful (i.e. if no error messages were displayed) or **N** if an error occurred. If errors were encountered you may wish to retry the compression procedure or quit ***HAFU*** and take other steps. Compression errors are very rare, in fact we have yet to encountered one while working with our data (the error shown in Fig. 9 is a simulation).

```
LIST    1         01/26/95 08:35 • ZIP.CHK

PKUNZIP (R)    FAST!    Extract Utility    Version 2.04g  02-01-93
Copr. 1989-1993 PKWARE Inc. All Rights Reserved. Registered version
PKUNZIP Reg. U.S. Pat. and Tm. Off.

_ 80486 CPU detected.
_ EMS version 4.00 detected.
_ XMS version 2.00 detected.
_ DPMI version 0.90 detected.

Searching ZIP: 94A238.ZIP
Testing: A2380000.RAW  PKUNZIP: (W15) Warning! file fails CRC check
Testing: A2380000.ECH  OK
Testing: A2380000.FSH  OK
Testing: A2380000.INT  OK
Testing: A2380100.RAW  OK
Testing: A2380100.ECH  OK
Testing: A2380100.FSH  OK
Testing: A2380100.INT  OK
Testing: A2380200.RAW  OK
Testing: A2380200.ECH  OK
Testing: A2380200.FSH  OK
Testing: A2380200.INT  OK
Command•    *** Top-of-file ***          Keys: •••• PgUp PgDn  F10=exit F1=Help
```

Fig. 9: File compression verification screen. An error is shown for the first file compressed.

B.2.2) Convert HTI RAW files to PBS RAW file.

This item converts all HTI RAW files that fall within a user specified period, into a PBS RAW file. See appendix A for a full description of the RAW file type. To begin this procedure enter the system number (1 or 2), the start and end day, and start and end times of the data you are interested in. Times must be entered as 4 digits representing the hour and minute on a 24 hour clock starting at 0000 at midnight and ending at 2400 at midnight the next day.* Once your entries are complete verify your choices by pressing **Y** or **N** after the "Is the above correct (Y/N)?" prompt. Fig. 10. shows an example input screen after the user has entered all required information and is being asked to verify that the information is correct.

```
Input: ESC to cancel
System = 1
Year = 1994
Start Julian Day = 231      End Julian Day = 234
Start time       = 2230     End time       = 0030

Is the above correct (Y/N)?
```

Fig. 10: "Convert HTI RAW files to PBS RAW file" verification screen.

Once you press **Y**, ***HAFU*** searches the current directory for a compressed file that matches the input criteria.** If the appropriate compressed file is found, any

---

* See appendix C for a complete description of input conventions.
** See appendix B for a complete description of naming conventions.

RAW files that fall within the period specified are extracted and converted to PBS format. ***HAFU*** uses information found in each file's parameter section to calculate additional variables of interest such as beam pattern factor and target strength. The parameter sections are then left out of the resulting PBS RAW files. When all conversions are complete the PBS RAW files are concatenated together into two files containing the information for the specified period of interest. One file contains data collected on port 1 and the other contains data collected on port 2. Note that if only one port was used to collect data, the file representing data from the other port consists of only a single header line. This file should later be deleted.

When the conversion process is complete, the display switches to a view of the RESULTS directory, showing a list of the files contained there (Fig. 11). This list includes the PBS RAW files that were just produced, as well as any PBS files from previous procedures. To view any of these files, use the cursor control keys (⇧⇩⇦⇨) to position the highlight bar over the file name and then press **ENTER**. When you have finished viewing files, continue to press **ESC** until you are back at the ***HAFU*** main menu.

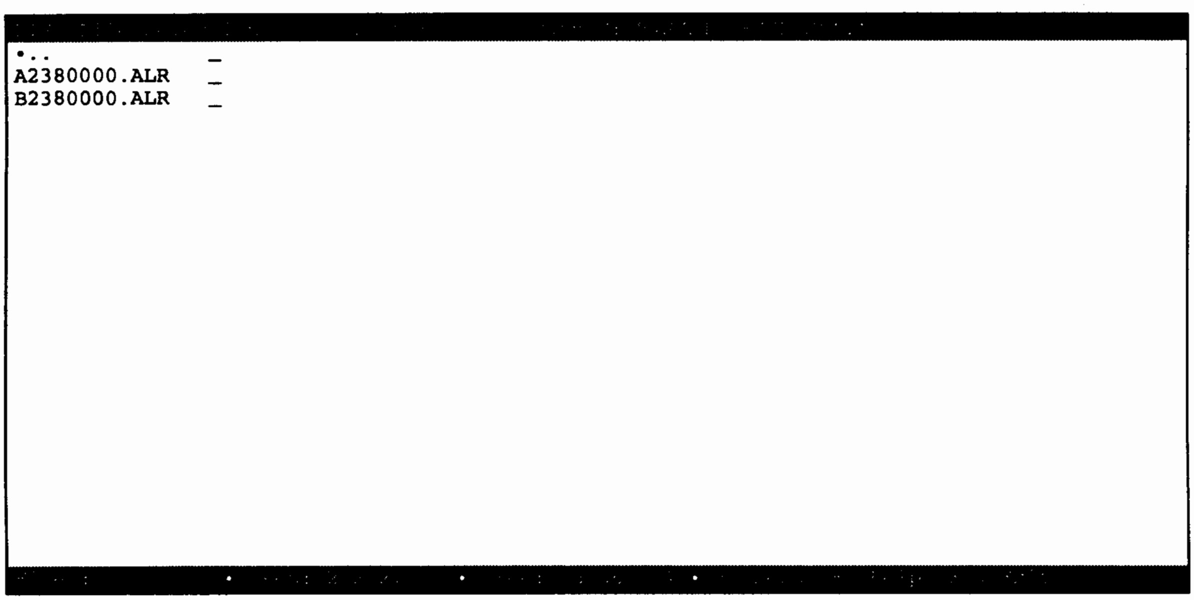

Fig. 11: The RESULTS directory with two PBS RAW files listed. One represents data collected on port 1 (A2380000.ALR), the other represents data collected on port 2 (B2380000.ALR).

B.2.3) Convert HTI ECHO files to PBS ECHO file.

This item operates identically to the "Convert HTI RAW files to PBS RAW file" item, except that the resulting files are ECHO format, not RAW. Follow the steps outlined in **B.2.2** to use this procedure.

B.2.4) Convert PBS ECHO file to PBS FISH file.

This item converts PBS ECHO files (created with the item "Convert HTI ECHO files to PBS ECHO file") to PBS FISH files. To use this item, enter the name of the PBS ECHO file you wish to convert and the ping rate used to collect the data. You are asked to verify your entries before the conversion takes place. During the conversion the status window displays the prompt "Processing ..." and when completed, the source PBS ECHO file and target PBS FISH file names are displayed (Fig. 12). When the conversion is complete, press any key to return to the ***HAFU*** main menu.

```
Status
Processing ...
Done: a2380000.ale -> a2380000.alf
at 10 pings/sec.
Conversion complete.
Press a key to continue.
```

Fig. 12: Status window upon completion of PBS ECHO file to PBS FISH file conversion.

B.2.5) Merge HTI RAW files.

Occasionally it's necessary to reprocess RAW data using HTI's *DSBP* software. This software will accept any HTI RAW file and re-track the data, creating ECHO, FISH, and SUMMARY files as output. This procedure can be very time consuming when one is dealing with dozens of RAW files. The menu item "Merge HTI RAW files" is designed to expedite reprocessing of HTI RAW files by concatenating all HTI RAW files that fall within a user-specified time frame. The concatenated files are split into separate files for each port and a new set of files is produced each time a change in a parameter value is encountered in the original HTI RAW files. This can greatly reduce the number of HTI RAW files you must deal with and also provides a clear indication of when a parameter change occurred. For example, suppose you have six HTI RAW files representing data collected from two ports over a period of six hours, and that the same parameters were used to collect all of these data. The "Merge HTI RAW files" procedure will create two HTI RAW files from these data, one file containing the data from port 1 and one file containing the data from port 2.

As with previous menu-items, you must enter the system number, year, starting and ending day, and starting and ending times. ***HAFU*** then searches the appropriate compressed files for HTI RAW files that fall within the period specified.

B.2.6) Display Upstream Tracked Fish Counts.

This item is not yet implemented as it requires that HTI make some small modifications to the way that the SUMMARY file is written. However, you can still use this procedure provided that your SUMMARY files summarize all of the data collected on a specific day, and only the data for that day.

B.2.7) View Results.

This item executes the shareware program called ***LIST***, in the `RESULTS` directory under the current working directory. This allows you to view any of the results from your ***HAFU*** session by positioning the highlight bar over a file name and pressing **`ENTER`**. You can also perform several file management activities from within ***LIST***. Refer to the ***LIST*** documentation or press the **`F1`** key from within ***LIST*** for more information.

B.2.8) Shell to DOS.

This item allows you to temporarily exit ***HAFU*** and access the DOS command-line. When you are ready to return to ***HAFU***, enter **`EXIT`**.

B.2.9) Quit.

This item quits ***HAFU*** and returns you to the operating system.

CHAPTER 2 - *QTS*, QUALARK TOOLS FOR S-PLUS

A) OVERVIEW.

QTS is a collection of S-Plus routines that we developed while working at our hydroacoustic site near Qualark Creek on the Fraser River, just north of Hope. These tools are primarily designed to graph data, but they also provide options for producing summaries of fish passage and for editing data interactively. ***QTS*** is written in the S language and requires the Windows version of S-Plus to run. A full description of the S language is given in Becker *et al*, 1988.

Like ***HAFU***, ***QTS*** provides a menu-driven interface. You can access this menu by double-clicking on the ***QTS*** icon in the Program Manager of Windows, just as you would any Windows application. Double-clicking on the ***QTS*** icon launches S-Plus for Windows and executes the appropriate S code to initialize the ***QTS*** menu. Fig. 13 shows the ***QTS*** icon in a program group with other application icons.

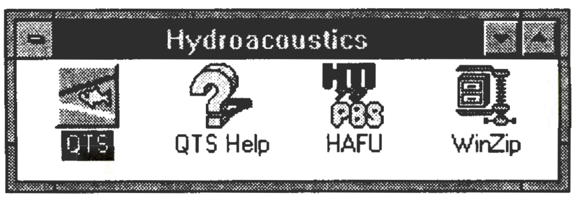

Fig. 13: The *QTS* icon in a Program Manager group.

When the ***QTS*** main menu appears, activate a menu item by double-clicking on the menu item text. For example to view a Windows help file concerning ***QTS***, double click on the text that reads "View on-line help". To leave a sub-menu and return to the main menu, double-click on the text that reads "Leave this menu". There is only one level of sub-menu under the main menu so selecting "Leave this menu" will always return you to the main menu. The complete menu structure of ***QTS*** is shown in Fig. 14.

In addition to the ***QTS*** menu, S-Plus also displays a graphics window and a command window. The graphics window displays various graphs selected from the ***QTS*** menu such as histograms and images. The command window displays text messages and prompts, and also accepts text input. Most of the ***QTS*** menu items require that you enter some information into the command window, such as the names of data frames and labels for plots. Fig. 15 shows the S-Plus display when ***QTS*** is running.

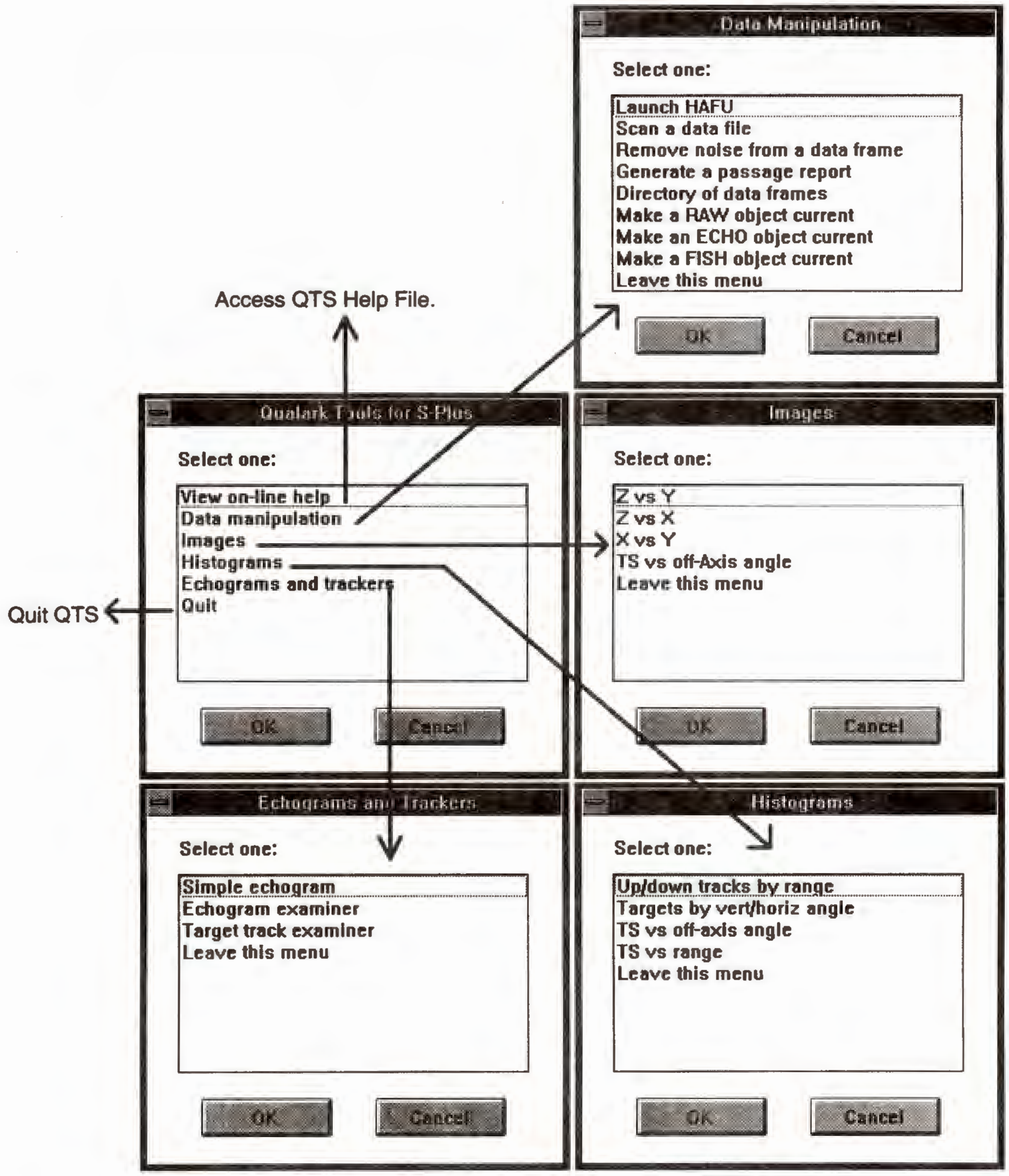

Fig. 14: Overview of the *QTS* menu structure.

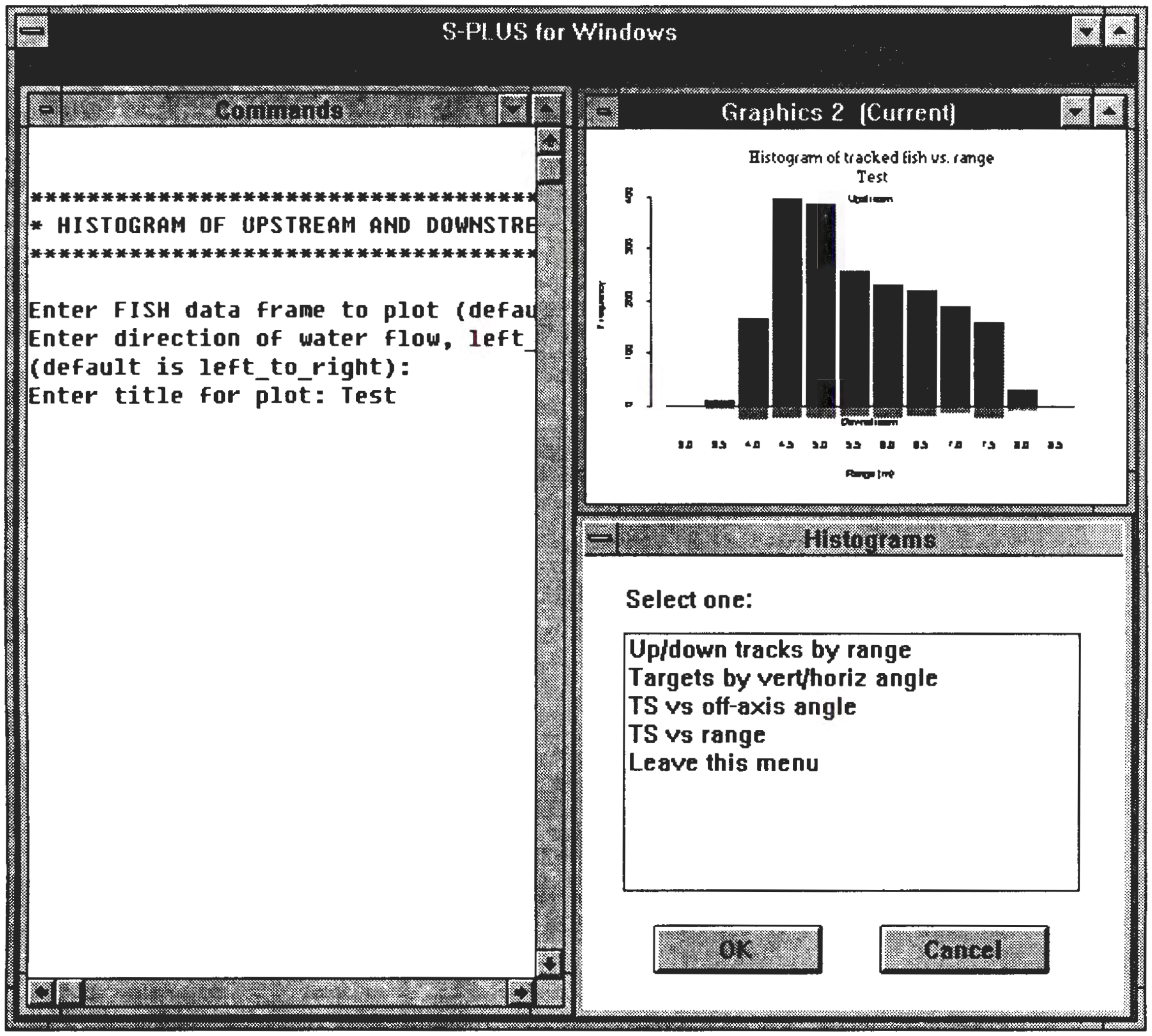

Fig. 15: The layout of S-Plus for Windows when *QTS* is running. Note the command window, graphics window, and *QTS* menu.

B) *QTS* USER'S MANUAL.

B.1) Main Menu Items.

B.1.1) View on-line help.

This item accesses a Windows help file on ***QTS***. The help system includes standard Windows help features such as hypertext links that allow you to to jump to topics by clicking on certain words or phrases indicated by green, underlined text. See the Windows user manual for more information on using this help system. Fig. 16 shows the Windows help system running the ***QTS*** help file.

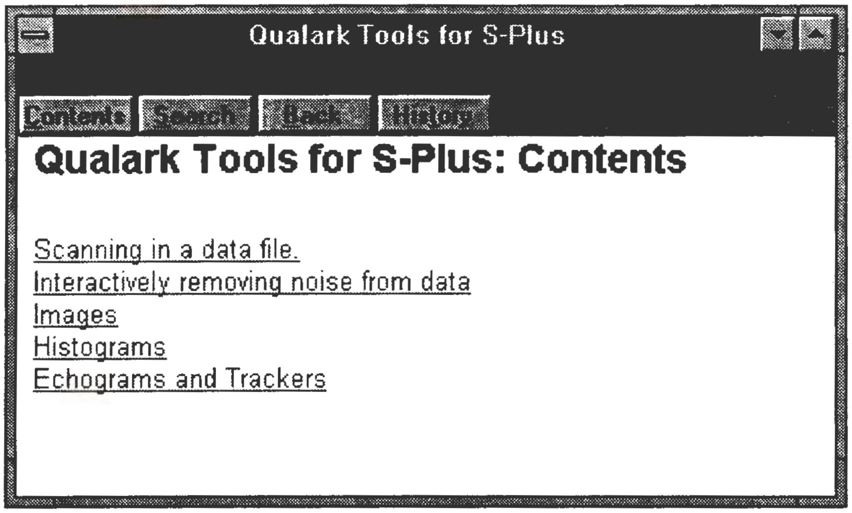

Fig. 16: The *QTS* help system.

B.1.2) Data manipulation.

This item brings up the sub-menu called "Data Manipulation" which provides items to convert data files to S-Plus format, to edit data sets interactively, and to create summaries of fish passage.

B.1.3) Images.

This item brings up the sub-menu called "Images" which allows you to choose from several different image plots. Images are two-dimensional histograms in which two variables form a grid of some pre-defined spacing. The number of observations falling within each cell of the grid is summed, and the relative difference in frequencies among cells is indicated by differences in cell colour or shades of gray. For gray-scale images, cells with no observations are coloured black while the the cells with the highest number of observations are coloured white. For all of these routines you may plot a RAW, ECHO, or FISH data frame. Note that when using a FISH data frame, all coordinates are defined as the initial position that each fish was detected in the beam.

B.1.4) Histograms

This item brings up the sub-menu called "Histograms" which allows you to choose from several different histogram plots. Histograms graphically display the freqency of observation of some variable summed over regular intervals. The freqeuncy at each interval is represented by a bar of variable height where the interval with the greatest frequency is represented by the tallest bar. Unless otherwise indicated, a RAW, ECHO, or FISH data frame may be plotted.

B.1.5) Echograms and trackers.

This item brings up the sub-menu called "Echograms and Trackers" which allows you to choose from echograms and tracker plots. Echograms are plots of detected echoes shown on a time (horizontal axis) vs. range (vertical axis) display. Trackers display the trajectory of individual tracked targets.

B.1.6) Quit.

This item quits ***QTS*** and ends your S-Plus session.

B.2) The Data Manipulation Menu.

B.2.1) Launch *HAFU*.

This item launches ***HAFU***. Enter the name of the directory that you wish to run ***HAFU*** from. This should be the name of the directory containing the HTI files you wish to analyze. Note that ***HAFU*** can also be run as a stand-alone DOS program, by entering **HAFU** at the DOS prompt.

B.2.2) Scan a data file.

This item allows you to convert a data file produced by ***HAFU***, into S-Plus binary format. This step is necessary before any plots or summaries can be produced since S-Plus can only work with it's own format of data file. Enter the name of the source data file and a name for the target data frame (data frames are a particular kind of S-Plus data set).

Example:

```
**************************************
* SCAN A DATA FILE INTO A DATA FRAME *
**************************************

Enter a name for the target data frame: a244.fsh
Enter the source file name (give full path): c:\94sys1\results\a2440000.alf
```

B.2.3) Remove noise from a data frame.

This item allows you to remove echoes from a data frame using visual tools. This is useful for eliminating rocks or other non-fish targets. The display consists of two windows, one titled *brush* that shows selected variables from the given data frame

plotted against each other, and one titled *spin* that shows any three of these variables in a 3-D plot that can be rotated and expanded. Use the left mouse button to highlight any echoes that you wish to remove from the data. A small box in the lower right of the display lists the target strength, in decibels, of all echoes displayed. As you highlight echoes with the mouse, the corresponding target strength is highlighted in this box. This is useful for checking the target strength of individual echoes. Fig. 17 shows a display of this routine. See S-Plus documentation for more information on using the brush/spin display.

Example:

```
***********************************
* REMOVE NOISE FROM A DATA FRAME *
***********************************

Enter a name for the target data frame: newa244.fsh
Enter the name of the source data frame: a244.fsh
```

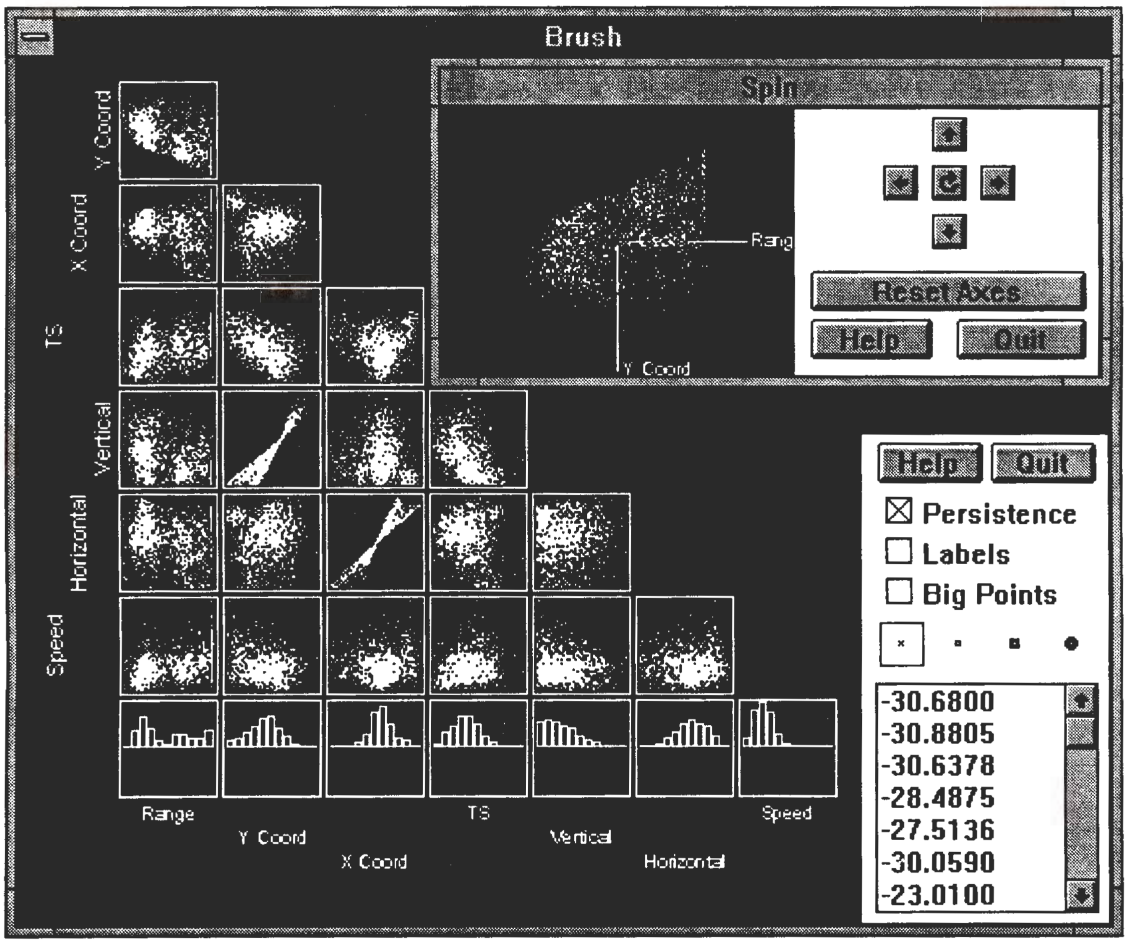

Fig. 17: Screen-display of the brush and spin plot from the "Remove noise from a data frame" menu option.

B.2.4) Generate a passage report.

This item generates a table, output to an Excel spreadsheet, of upstream and downstream passage per hour for a given time frame (Table 2). The data are also displayed graphically (Fig. 18). This is a useful tool for producing daily summaries of fish passage through the beam. The count is automatically expanded for the portion of each hour that the beam was not operated. For example, if two beams were multiplexed* at 15 minute intervals, each beam would collect data for 30 minutes out of each hour. This procedure multiplies the count in each beam to make an estimate of the total number of fish that passed through the beam each hour. Thus, the count would be expanded by a factor of 2 for a beam that operated for 30 minutes out of each hour. The direction of water flow past the beam must be entered so that upstream and downstream passing fish can be correctly identified. Water flow direction is defined as **`left_to_right`** or **`right_to_left`**, as seen from the river bank looking out into the river.

Example:

```
*************************
* GENERATE DAILY REPORT *
*************************

Enter source FISH data frame (default is last FISH file scanned): a255.fsh
Enter number of minutes of data collected per hour (default is 60 min): 30
Enter the direction of water flow (right_to_left or left_to_right)
Default is left_to_right: left_to_right
Enter title:
```

Table 2: Summary table produced by the "Generate a passage report" procedure.

Unvalidated Expanded Fish Passage.
Julian Day(s): 244 to 244 . Flow = Left to right. Expansion Factor = 2

Julian Day	Start Hour	End Hour	Up Stream	Down Stream	Avg TS	Avg Speed
244	0	1	228	28	-29.58	1.23
244	1	2	278	60	-28.59	1.45
244	2	3	218	56	-28.75	1.39
244	3	4	260	58	-28.6	1.39
244	4	5	356	140	-28.23	1.48
244	5	6	120	14	-27.33	1.45
244	6	7	102	14	-27.55	1.42
Total Passage:			**1562**	**370**		
Hourly Mean Passage:			**223.14**	**52.86**	**-28.38**	**1.4**

* Multiplexing refers to switching echousounder operation between two transducers at some regular interval.

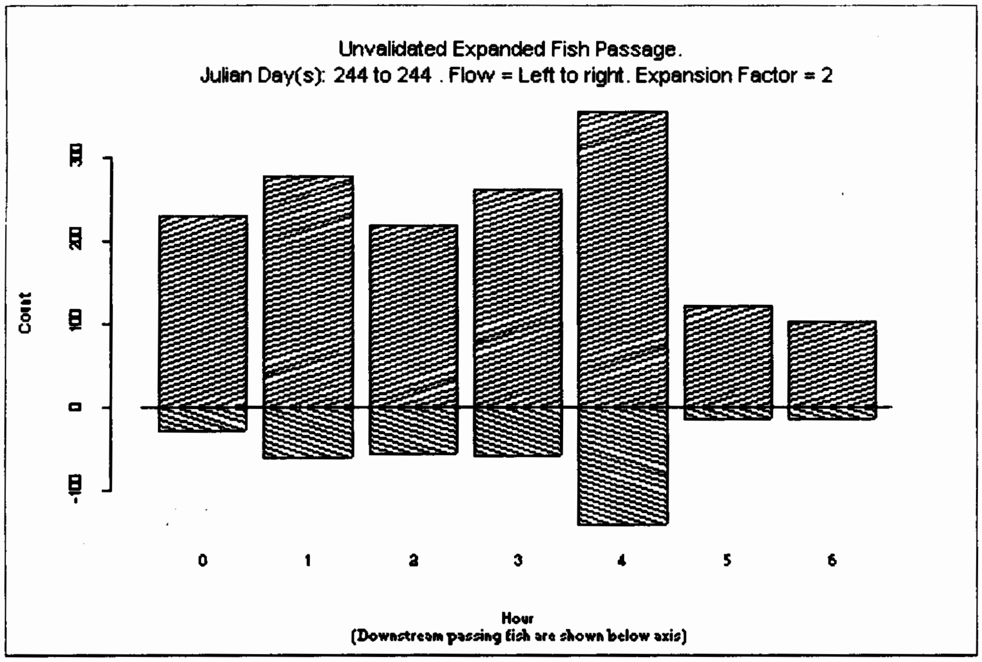

Fig. 18: Plot produced by the "Generate a passage report" menu item.

B.2.5) Directory of data frames.

This item lists all available data frames (data objects that can be passed as arguments to the various plotting routines).

Example:

```
***************************************
* DIRECTORY OF AVAILABLE DATA FRAMES *
***************************************

            data.class storage.mode      extent object.size     dataset.date
CURRENT.ECH data.frame         list  9263 x 16     1268743 95.01.09  15:42
CURRENT.FSH data.frame         list  1076 x 22      199030 95.01.09  15:42
CURRENT.RAW data.frame         list 13360 x 15     1726472 95.01.09  15:42
   a244.ech data.frame         list  9263 x 16     1268743 95.01.09  14:02
   a244.fsh data.frame         list  1076 x 22      199030 95.01.09  14:03
   a244.raw data.frame         list 13360 x 15     1726472 95.01.09  14:50
newa244.fsh data.frame         list   970 x 22      179449 95.01.10   9:05
```

B.2.6) Make a RAW object current.

This item allows you to make a RAW data frame the current RAW data frame. Use this procedure when you wish to pass the same RAW data frame as an argument to several different routines without having to retype the name of the data frame each time. This only applies to routines that use a RAW data frame as a default argument.

B.2.7) Make an ECHO object current.

This item is the same as **B.2.6** but applies to an ECHO data frame.

B.2.8) Make a FISH object current.

This item is the same as **B.2.6** but applies to a FISH data frame.

B.3) The Images Menu.

B.3.1) Z vs Y.

This item produces a density image of target frequency in the Z (Distance from the transducer face, in meters) vs Y (vertical coordinate in meters) plane (Fig. 19). A scatter plot of the same data is shown below the image.

Example:

```
***************************************
* IMAGE OF Z (RANGE) VS Y (VERTICAL) *
***************************************

Enter data frame to plot (default is current ECHO): a244.ech
Enter title for plot: Echo Data.
```

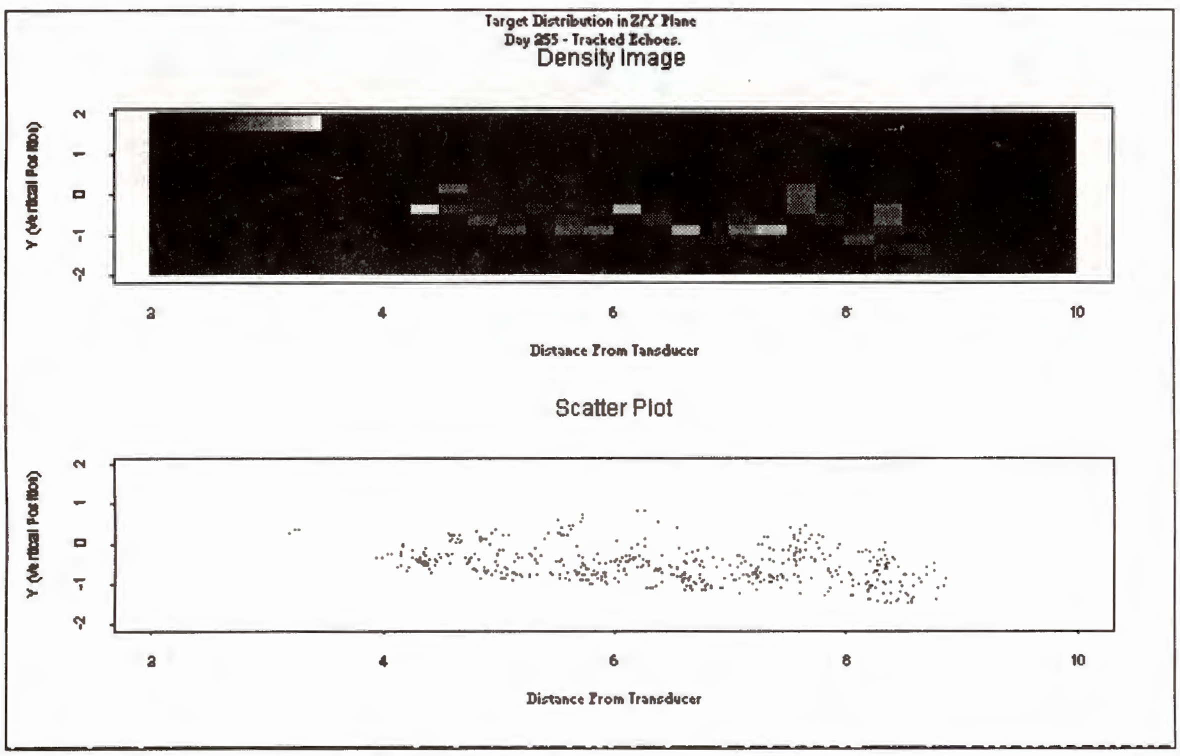

Fig. 19: Z vs. Y density image.

B.3.2) Z vs X.

This item produces a density image of target frequency in the Z (Distance from the transducer face, in meters) vs X (horizontal coordinate in meters) plane (Fig. 20). A scatter plot of the same data set is shown below the image.

Example:

```
****************************************
* IMAGE OF Z (RANGE) VS X (HORIZONTAL) *
****************************************

Enter data frame to plot (default is current ECHO): a244.ech
Enter title for plot: Echo Data.
```

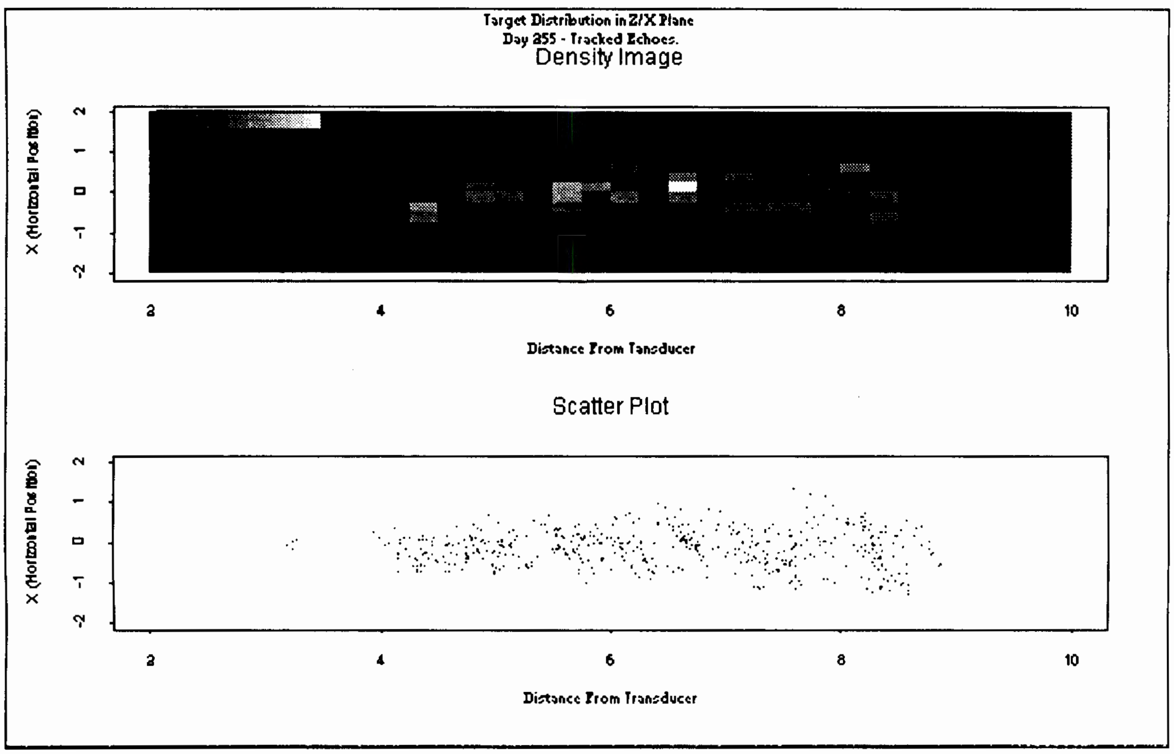

Fig. 20: Z vs. X density image.

B.3.3) X vs Y.

This item produces a density image of target frequency in the X (horizontal coordinate in meters) vs Y (vertical coordinate in meters) plane (Fig. 21). A scatter plot of the same data set is shown to the right of the image.

Example:

```
*********************************************
* IMAGE OF X (HORIZONTAL) VS Y (VERTICAL) *
*********************************************

Enter data frame to plot (default is current ECHO): a244.ech
Enter title for plot: Echo Data.
```

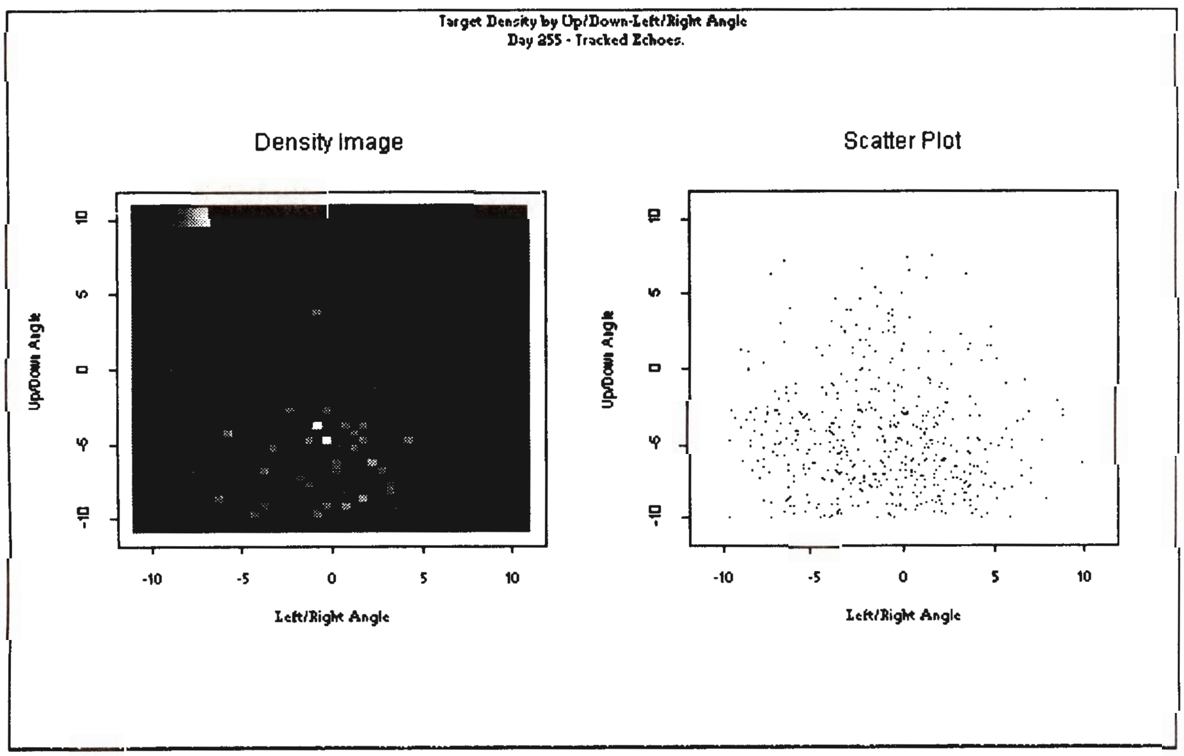

Fig. 21: X vs. Y density image.

B.3.4) TS vs off-axis angle.

This item produces a density image of target strength, in decibels, vs. off-axis angle (angle from the centre of the beam, in degrees), (Fig. 22. A scatter plot of the same data set is shown below the image. Note that this plot is only appropriate for beams with circular cross-sections.

Example:

```
*********************************************
* IMAGE OF TARGET STRENGTH VS OFF-AXIS ANGLE *
*********************************************

Enter data frame to plot (default is current ECHO): a244.ech
Enter title for plot: Echo Data.
```

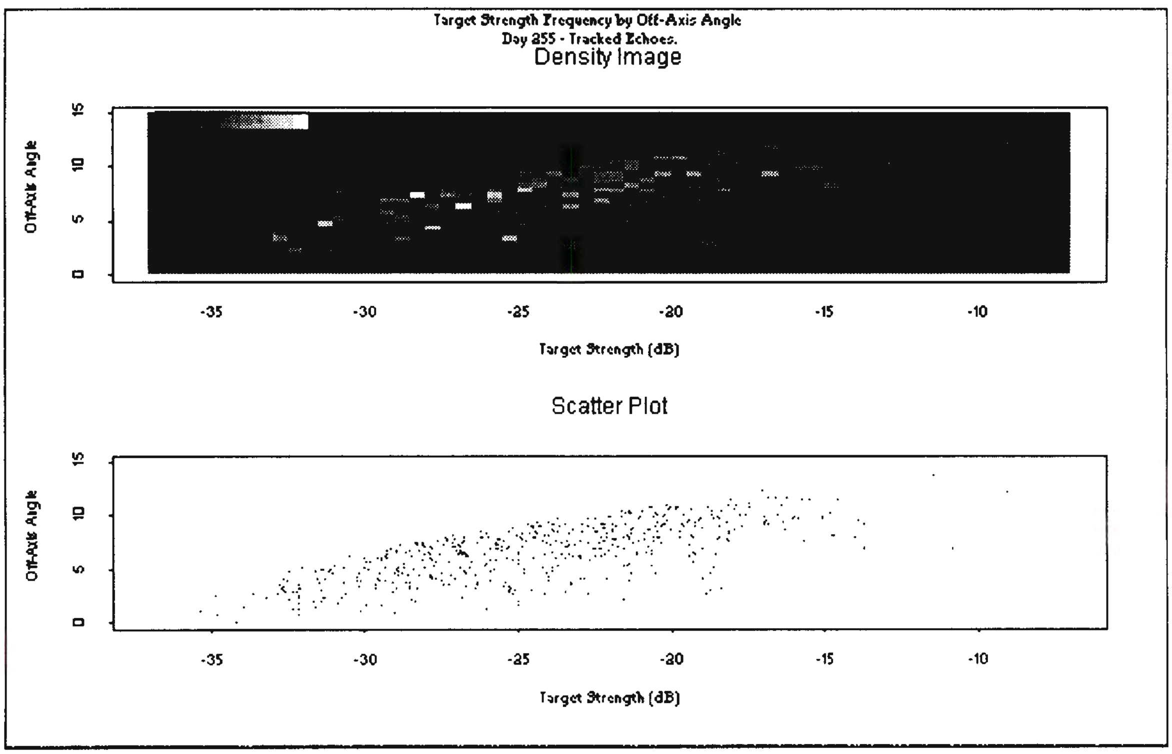

Fig. 22: Target strength vs. off-axis angle density image.

B.4) The Histograms Menu.

B.4.1) Up/down tracks by range.

This item produces a histogram of tracked targets by range, in meters (Fig. 23). Upstream-migrating targets are shown above the x-axis, downstream-migrating targets are shown below the x-axis. Only FISH data frames may be used with this routine.

Example:

```
*******************************************************************
* HISTOGRAM OF UPSTREAM AND DOWNSTREAM TRACKED TARGETS BY RANGE *
*******************************************************************

Enter FISH data frame to plot (default is current): a255.fsh
Enter direction of water flow, left_to_right or right_to_left.
(default is left_to_right): left_to_right
```

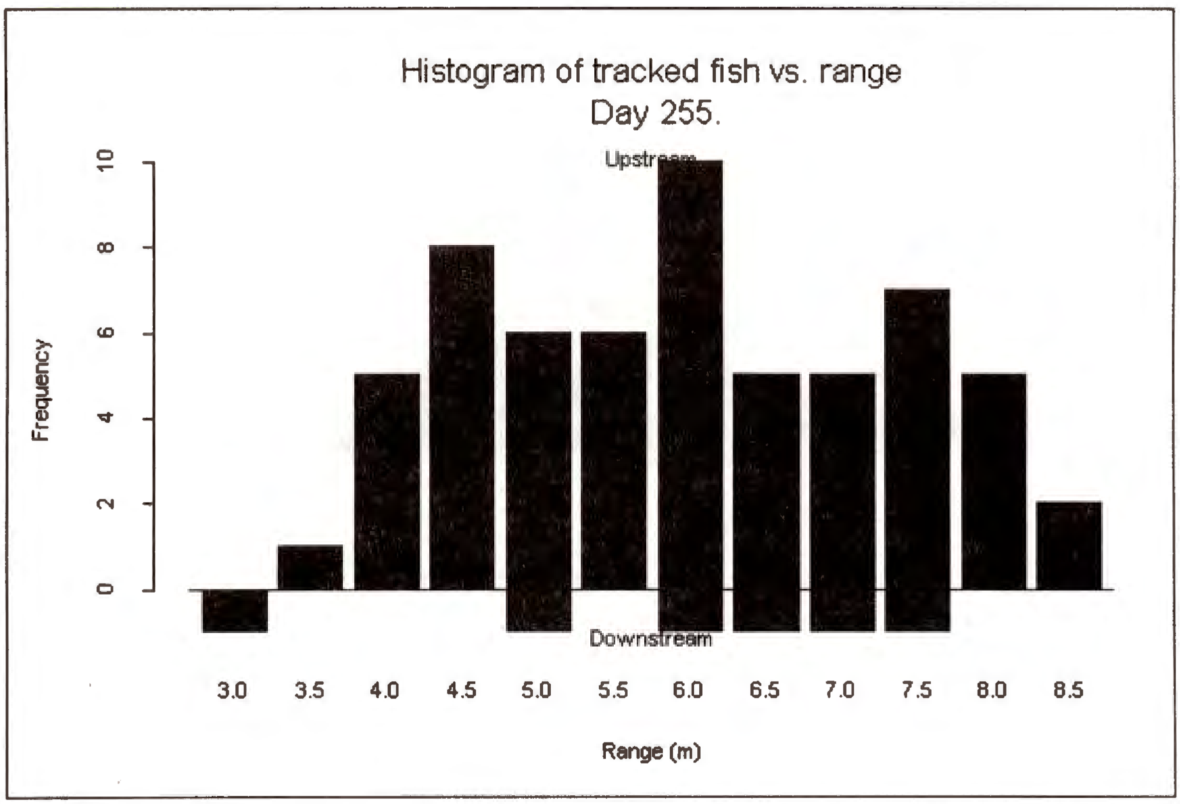

Fig. 23: Histogram of upstream and downstream tracked targets by range.

B.4.2) Targets by vert/horiz angle.

This item produces histograms of target frequency vs vertical angle and horizontal angle, in degrees (Fig. 24).

Example:

```
*********************************************************
* TARGET DISTRIBUTION BY VERTICAL AND HORIZONTAL ANGLE *
*********************************************************

Enter data frame to plot (default is last ECHO scanned): a244.ech
Enter title for plot: Day 255.
```

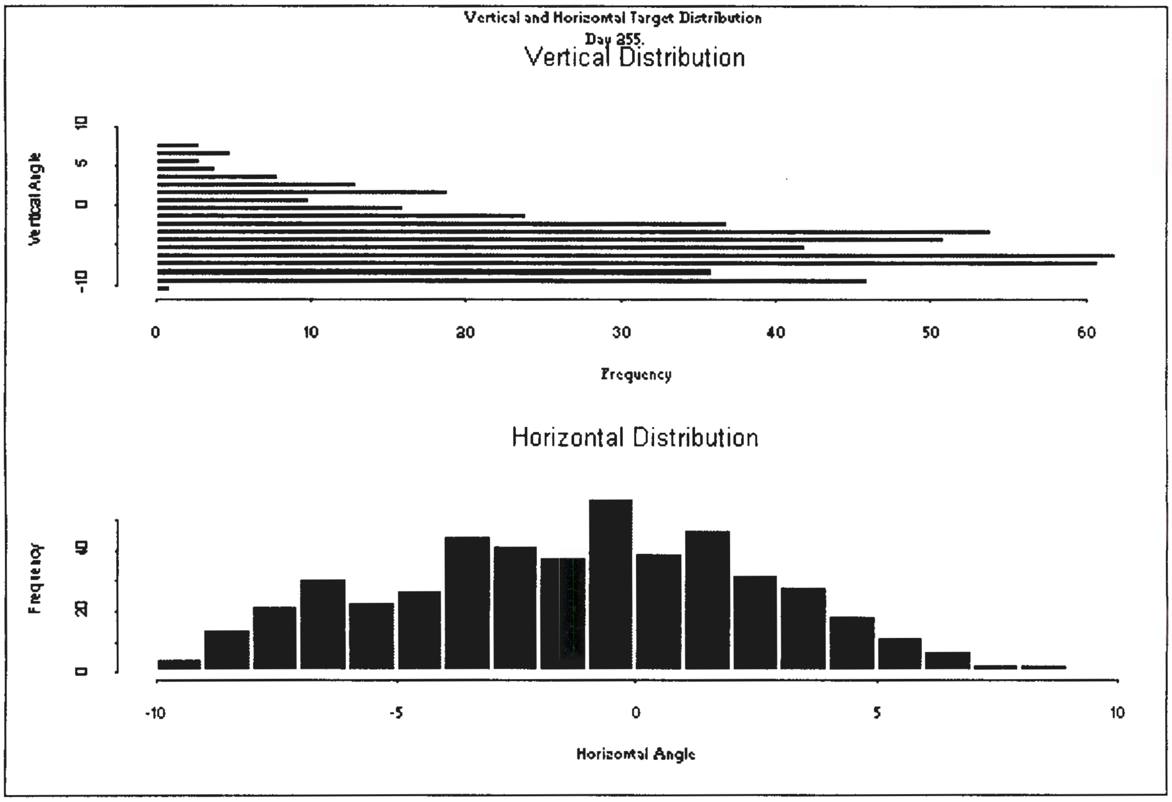

Fig. 24: Histograms showing target frequency vs. vertical angle (degrees) and target frequency vs. horizontal angle (degrees).

B.4.3) TS vs off-axis angle.

This item produces histograms of target strength, in decibels, for each degree of off-axis angle spanned by the data (Fig. 25). Note that this plot is only appropriate for beams with circular cross-sections.

Example:

```
*****************************************************
* HISTOGRAMS OF TARGET STRENGTH PER OFF-AXIS ANGLE *
*****************************************************

Enter data object to plot (default is last ECHO scanned): a244.ech
Enter title for plot: Echo Data.
```

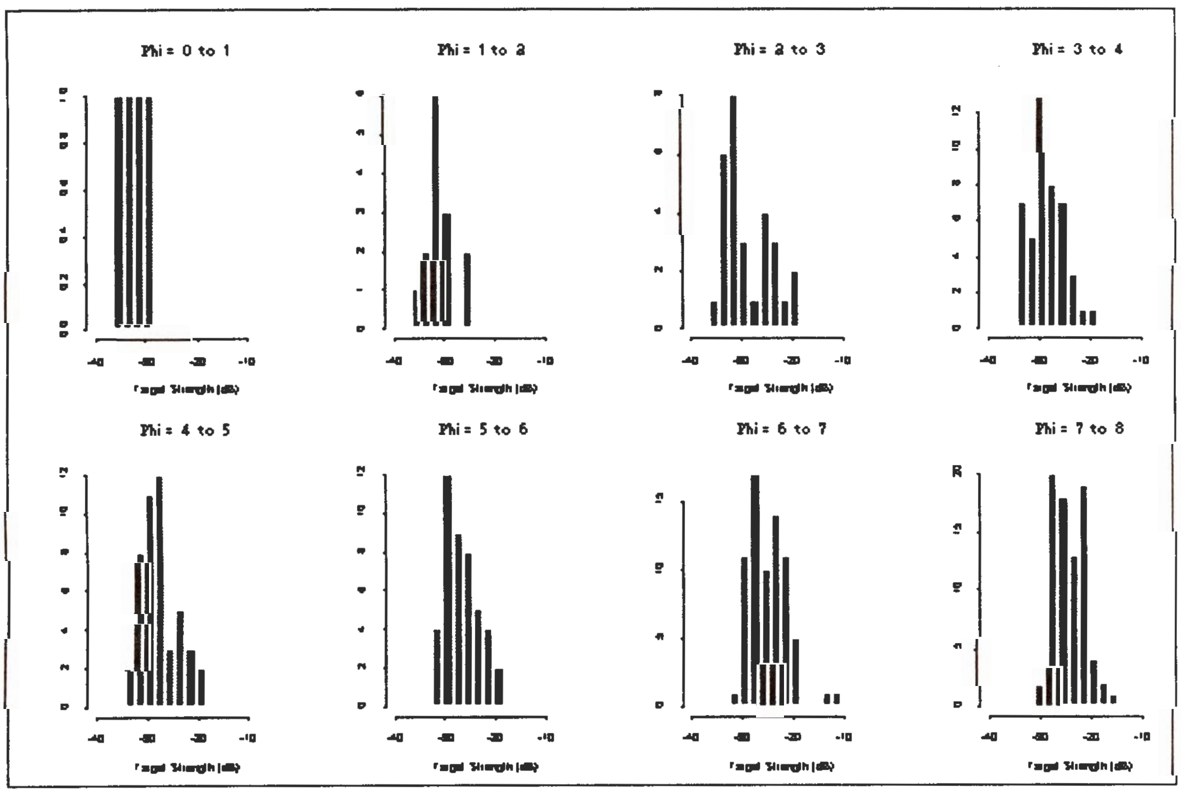

Fig. 25: Histograms of target strength (dB) for each degree of off-axis angle spanned by the data.

B.4.4) TS vs range.

This item produces histograms of target strength, in decibels, for each meter of range spanned by the data (Fig. 26).

Example:

```
************************************************
* HISTOGRAMS OF TARGET STRENGTH PER METER RANGE *
************************************************

Enter data object to plot (default is last ECHO scanned): a244.ech
Enter title for plot: Echo Data.
```

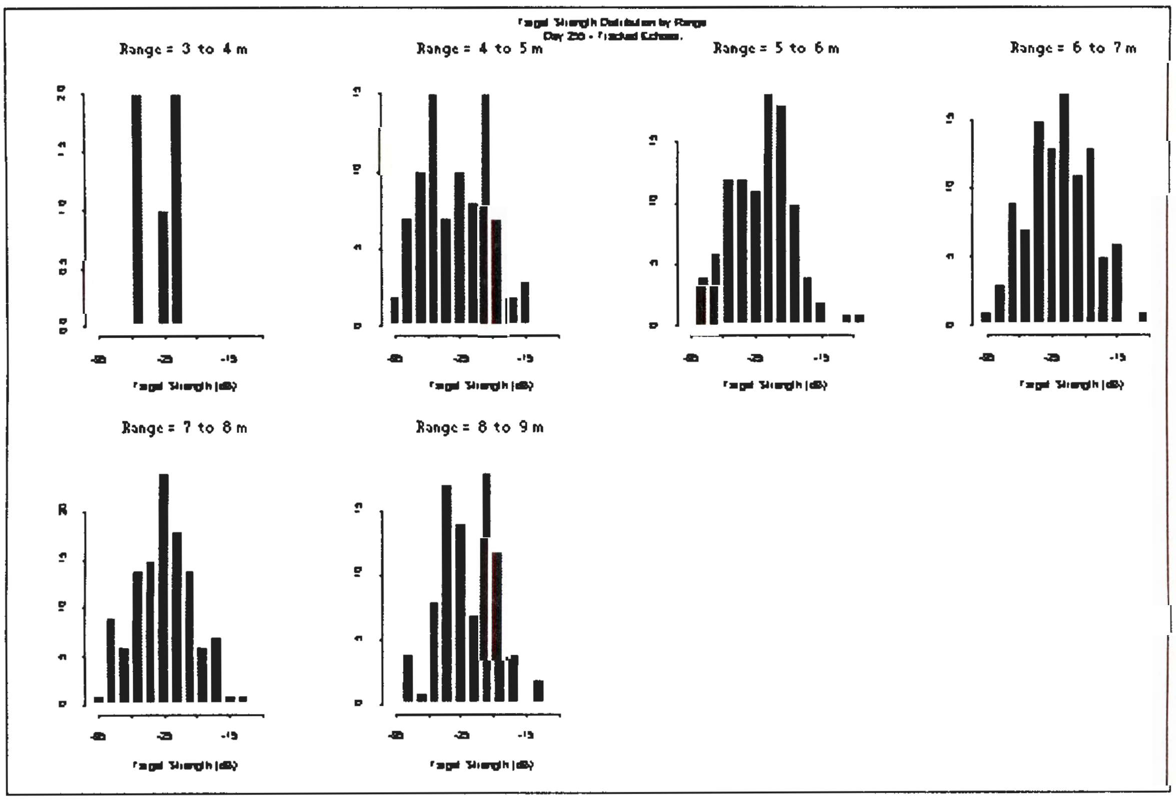

Fig. 26: Histograms of target strength (dB) for each meter of range spanned by the data.

B.5) The Echograms and Trackers Menu.

B.5.1) Simple echogram.

This item produces a standard on-screen echogram that can be paged through in 6 minute intervals (Fig. 27). Echoes are displayed as short, black vertical bars. Grid lines divide the x-axis into 1-minute intervals and the y-axis into 1 metre intervals.

Example:

```
************
* ECHOGRAM *
************

Enter data object to plot (default is last RAW scanned): a255.raw
Enter start day (optional): 255
Enter start hour (optional): 2
Enter start minute (optional): 0
Enter start range in meters (optional): 2
Enter end range in meters (optional): 9
Enter title for plot (enter for none):
```

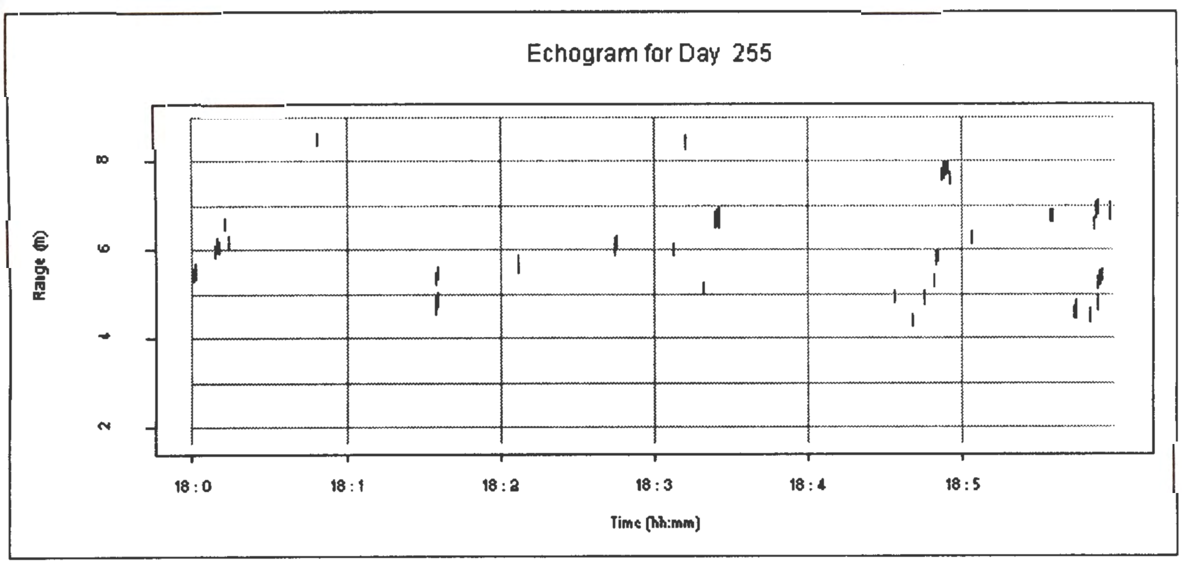

Fig. 27: Echogram as produced by the "Simple echogram" menu item.

B.5.2) Echogram Examiner.

This item produces an echogram of a RAW and an ECHO data frame (Fig. 28). Echoes are shown as short vertical bars with untracked echoes (from the RAW data frame) displayed in black and tracked echoes (from the ECHO data frame) displayed in some other colour. To view the trajectories of individual tracked targets, use the left mouse button to click on each highlighted track with the mouse pointer. When you have selected all the tracks you wish to view, click the right mouse button. You can then view the trajectories of each tracked target, on a horizontal vs. vertical angle display. When you have finished viewing tracks, select "Forward" to move on to the next echogram segment, "Backward" to move to the previous echogram segment, or "Pause" to rerun the current echogram segment.

Example:

```
********************************************
* EXAMINE TRACKS SELECTED FROM AN ECHOGRAM *
********************************************

Enter RAW data object (default is last scanned): a244.raw
Enter ECHO data object (default is last scanned): a244.ech
Enter start day (optional): 244
Enter start hour (optional): 2
Enter start minute (optional): 30
Enter start range in meters (optional): 2
Enter end range in meters (optional): 10
Enter beam x-section width (optional, default = 10 degrees off-axis): 10
```

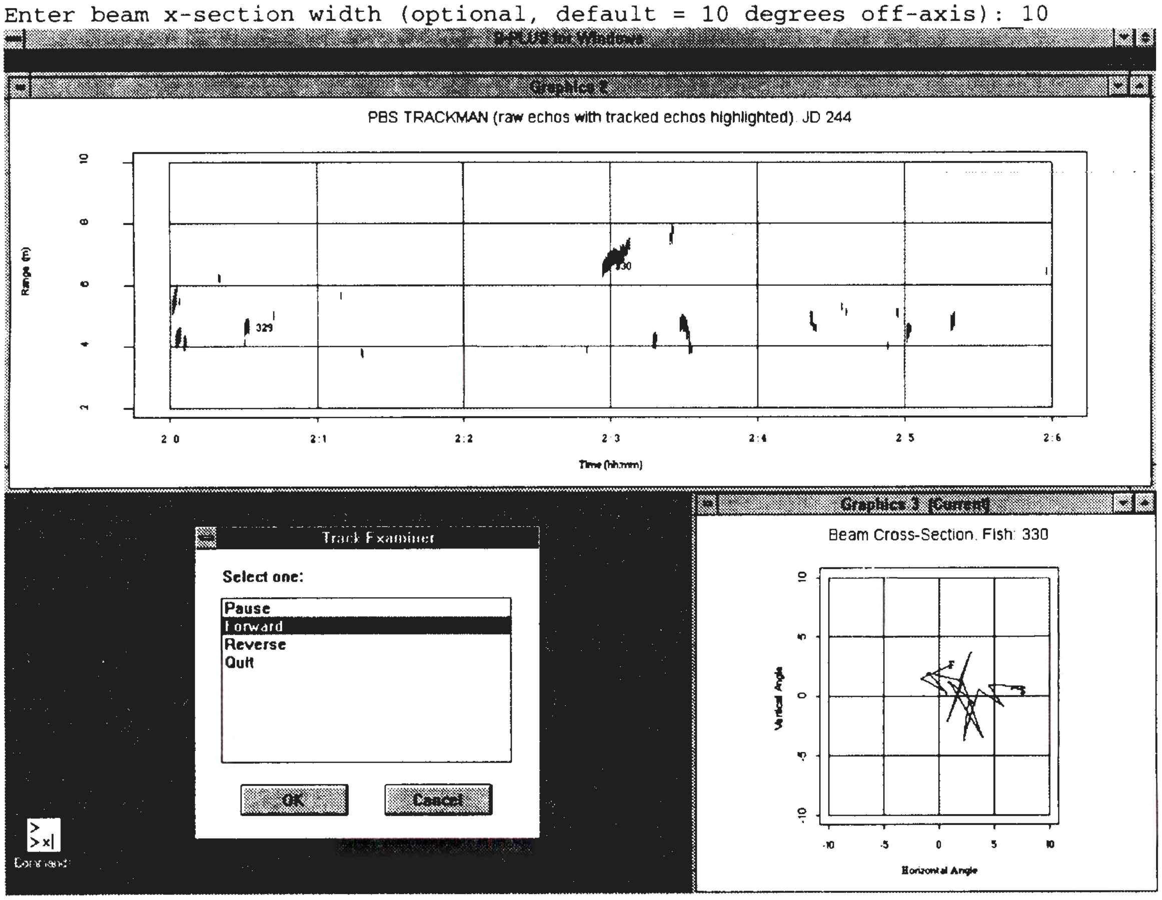

Fig. 28: Screen-display of the "Echogram examiner" routine.

B.5.3) Target track examiner.

This item produces a set of six plots that allow you to compare a tracked target with surrounding echoes (Fig. 29). The top left plot shows the tracked target in the beam cross-section (X vs. Y in meters). The plot to the right of this shows the tracked target with respect to horizontal position and range (X vs. Z in meters). The top right plot shows the ping sequence represented by the tracked target (the ping number of each echo returned from the target, relative to the total number of pings since the start of data collection) vs. the horizontal coordinate, in meters. The circles surrounding each point represent the relative target strength of each returned echo. The 3 bottom plots mirror the top ones but include a user-specified "buffer" period, in seconds, before and after the period during which the target was tracked. On these 3 plots the 'o' symbol represents echoes that were returned during the tracked target's passage (plus the buffer time) but that were not identified as belonging to any tracked fish. The '*' symbol represents echoes that were tracked but that belong to targets other than the currently displayed one. Example:

```
***********************************
* EXAMINE TRACKS TARGET BY TARGET *
***********************************

Enter RAW data object (default is last scanned): a244.raw
Enter ECHO data object (default is last scanned): a244.ech
Enter starting fish number (optional, default = 1): 35
Enter buffer time in seconds (optional, default = 2): 2
Enter beam width in degrees (optional, default = 8:) 8
```

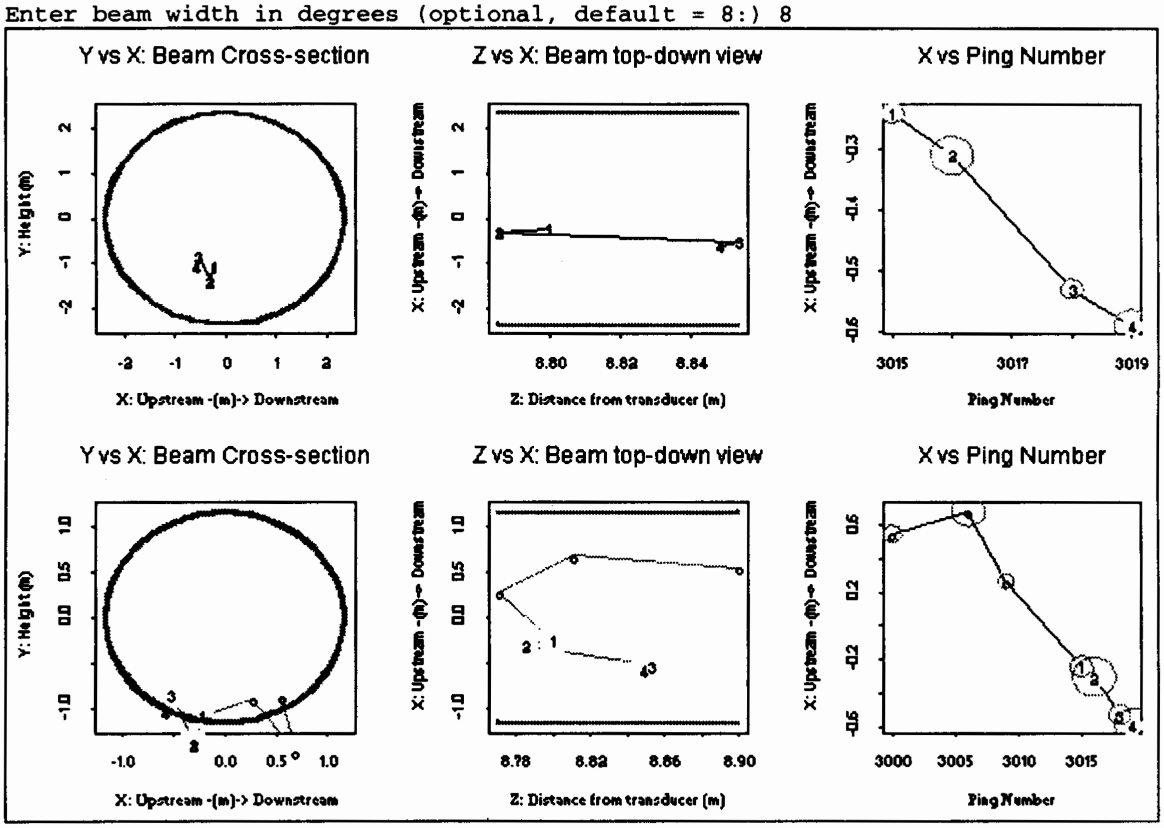

Fig. 29: Plots produced by the "Target track examiner" routine.

APPENDIX A - DATA FILE TYPES AND FORMATS

The following section describes the format of each type of HTI and PBS data file.

1) HTI RAW FILES:

RAW files include all detected echoes that pass a point-source target selection criteria. This can include echoes from fish, rocks, or other point-source targets. An example RAW file is shown in Fig. 1.

```
* Start Processing at Port 1  C:\SB\SBPORT1.PAR  Wed Oct 12 00:00:02 1994
* Data processing parameters used in collecting this file for Port 1
  100    -1      1
  101    -1      0
   .
   .
   .
  610    -1 OFF
  611    -1 D:\94SYS2\B
* Data processing parameters used in collecting this file for Port 2
  100    -1      2
  101    -1      0
   .
   .
   .
  610    -1 OFF
  611    -1 D:\94SYS2\B
*    Ping    Range   Sum Chan. -6dB -12dB -18dB    Up-Dn      Lf-Rt    Mux
*   Number  meters    Volts    P.W.  P.W.  P.W.    Angle      Angle    Port
       563    3.16    0.5359    10    10    12    2.1950    -3.3843    1
       564    3.16    0.3034     7     8     8    2.7752    -3.2484    1
* End Sample Block for Port 1  C:\SB\SBPORT1.PAR  Wed Oct 12 00:02:00 1994
       264    7.38    0.2173     8     8     8   -3.9969    -5.6333    2
       265    3.91    0.2454     8     8     8    6.4172    -2.1934    2
* End Sample Block for Port 2  C:\SB\SBPORT2.PAR  Wed Oct 12 01:00:00 1994
* Stop Processing.  C:\SB\SBPORT1.PAR  Wed Oct 12 01:00:00 1994
```

A

B

C

Fig. 1: Example HTI RAW data file. A = Section listing the file creation time and date, the port on which data collection begins, and the parameter values used to collect data on port 1. B = Section listing parameter values used to collect data on port 2. C = Section listing data collected and times when port switching occurred.

The contents of the HTI RAW file are listed in Table 1.

Table 1: Contents of the HTI RAW data file.

Column Heading	Contents
Ping Number	• Sequential ping number since the file start time.
Range meters	• Range of target in meters from the face of the transducer.
Sum Chan. Volts	• Peak output voltage summed over all 4 quadrants of the transducer.
-6dB P.W.	• Pulse width at -6dB from peak voltage.
-12dB P.W.	• Pulse width at -12dB from peak voltage.
-18dB P.W.	• Pulse width at -18dB from peak voltage.
Up-Dn Angle	• Horizontal position of target in degrees to the left or right of the vertical axis.
Lf-Rt Angle	• Vertical position of target in degrees above or below the horizontal axis.
Mux Port	• Multiplexer port on which data were collected.

2) PBS RAW FILES.

HAFU uses the parameter values for each port to calculate several additional fields. The parameter values are then discarded. An example of a PBS RAW file is shown in Fig. 2.

```
 jd    time      ping      x          y          z        range      pw          vert
 285  0.016194   563   -0.1864     0.1208     3.1522     3.1600  0.000208     2.1950
 285  0.016222   564   -0.1789     0.1528     3.1512     3.1600  0.000146     2.7752
 285  0.016250   565   -0.1250     0.1618     3.0632     3.0700  0.000167     3.0235
 285  0.016306   567    0.4669    -1.1235    10.2782    10.3500  0.000167    -6.2382

 horiz        phi     theta       scv        bpf        ts
-3.3843     4.0310  147.0509    0.5359    -5.7504   -26.3579
-3.2484     4.2686  139.5000    0.3034    -6.4053   -30.6444
-2.3359     3.8181  127.6786    0.3650    -5.1088   -30.3354
 2.6008     6.7508  292.5654    0.2130   -18.0709   -22.0515
```

Fig. 2: Example PBS RAW file (split).

The contents of the PBS RAW file are listed in Table 2.

Table 2: Contents of the PBS RAW file.

Column Heading	Contents
jd	• "Julian Day" defined here as the number of days since January 1st.
time	• Time in decimal hours on which ping occurred. A 24 hour clock starting at midnight (0.00) is used.
ping	• Sequence number of ping as recorded in the HTI RAW file.
x	• X position of target in meters to the left or right of the vertical axis.
y	• Y position of target in meters above or below the horizontal axis.
z	• Z position of target (range projected onto beam axis) in meters from the face of the transducer.
range	• Range of target in meters from the face of the transducer.
pw	• Pulse width at -12dB from peak voltage.
vert	• Vertical position of target in degrees above or below the horizontal axis.
horiz	• Horizontal position of target in degrees to the left or right of the vertical axis.
phi	• Spherical coordinate of target (Fig. 3).
theta	• Spherical coordinate of target (Fig. 3).
scv	• Peak output voltage summed over all 4 quadrants of the transducer.
bpf	• Beam pattern factor.
ts	• Target strength in dB.

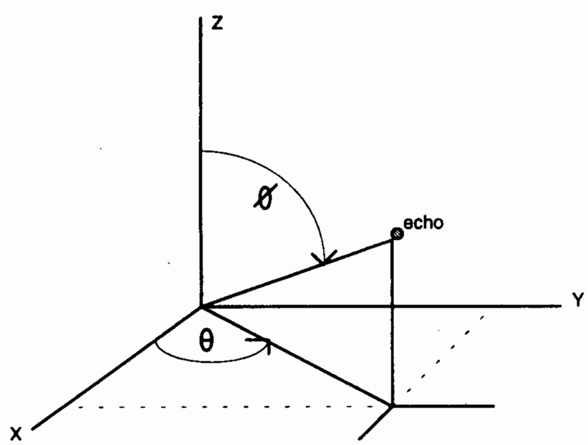

Fig. 3: Illustration of spherical coordinates phi (∅) and theta (θ). See Peterson, 1960 for a complete description of the spherical coordinate system. ∅ ranges from 0 to π while θ ranges from 0 to 2π.

3) HTI ECHO FILES.

ECHO files contain information on each ping returned from targets that are tracked. An example ECHO file is shown in Fig. 4.

```
* Start Processing at Port 1  C:\SB\SBPORT1.PAR  Wed Oct 12 00:00:02 1994
* Data processing parameters used in collecting this file for Port 1
   100    -1     1
   101    -1     0
    .
    .                                                                        A
    .
   610    -1 OFF
   611    -1 D:\94SYS2\B
* Data processing parameters used in collecting this file for Port 2
   100    -1     2
   101    -1     0
    .
    .                                                                        B
    .
   610    -1 OFF
   611    -1 D:\94SYS2\B
* Fish  Ping X dir. Y Dir. Range   -6 -12 -18 Sum Ch.  Beam P. Target
* Num.  Num. Coord. Coord. meters  PW  PW  PW  Volts   Factor  Strength
    352    563  -0.19   0.12   3.16  10  10  12  0.5359  -5.7482 -26.36
    352    564  -0.18   0.15   3.16   7   8   8  0.3034  -6.4021 -30.65
* End Sample Block for Port 1  C:\SB\SBPORT1.PAR  Wed Oct 12 00:02:00 1994   C
    354    264  -0.72  -0.51   7.38   8   8   8  0.2173 -18.3223 -21.63
    354    268  -0.52  -0.29   7.38   8   8   8  0.2960  -7.8267 -29.44
* End Sample Block for Port 2  C:\SB\SBPORT2.PAR  Wed Oct 12 01:00:00 1994
* Stop Processing.  C:\SB\SBPORT1.PAR  Wed Oct 12 01:00:00 1994
```

Fig. 4: Example HTI ECHO data file. A = Section listing the file creation time and date, the port on which data collection begins, and the parameter values used to collect data on port 1. B = Section listing parameter values used to collect data on port 2. C = Section listing data collected and times when port switching occurred.

The contents of the HTI ECHO file are listed in Table 3.

Table 3: Contents of the HTI ECHO data file.

Column Heading	Contents
Fish Num.	• Sequential fish number since echosounder began collecting data.
Ping Num.	• Sequential ping number since the file start time.
X Dir. Coord.	• Horizontal position of target to the left or right of the vertical axis, in meters.
Y Dir. Coord.	• Vertical position of target above or below the horizontal axis, in meters.
Range meters	• Range of target in meters from the face of the transducer.
-6dB PW	• Pulse width received at -6dB from peak voltage.
-12dB PW	• Pulse width received at -12dB from peak voltage.
-18dB PW	• Pulse width received at -18dB from peak voltage.
Sum Ch. Volts	• Peak output voltage summed over all 4 quadrants of the transducer.
Beam P. Factor	• Beam pattern factor.
Target Strength	• Acoustic size of target in dB.

4) PBS ECHO FILES.

As is the case with RAW files, ***HAFU*** uses information contained in the parameter section of the HTI ECHO file to calculate additional fields, after which the parameters are discarded. An example of a PBS ECHO file is shown in Fig. 5.

jd	time	fish	ping	x	y	z	range	pw	vert	horiz	phi	theta	scv	bpf	ts
285	0.016194	1	563	-0.1900	0.1200	3.1520	3.1600	0.000208	2.1803	-3.4496	4.0780	147.7244	0.5359	-5.7482	-26.3600
285	0.016222	1	564	-0.1800	0.1500	3.1513	3.1600	0.000146	2.7252	-3.2691	4.2523	140.1944	0.3034	-6.4021	-30.6500
285	0.016250	1	565	-0.1300	0.1600	3.0631	3.0700	0.000167	2.9901	-2.4302	3.8504	129.0939	0.3650	-5.1053	-30.3400
285	0.016333	1	568	-0.0500	0.1200	3.0072	3.0100	0.000229	2.2851	-0.9526	2.4753	112.6199	0.5408	-2.0752	-29.9500

Fig. 5: Example PBS ECHO file (split).

The column headings of the PBS ECHO file are the same as those in the PBS RAW file with one additional column, **fish,** which is the sequence number of fish since the start of the requested period of data. In other words, no matter what period of time the user chooses, the first fish detected in that time frame is numbered as 1.

5) HTI FISH FILES.

FISH files contain summary information on each target tracked by the system. An example FISH file is shown in Fig. 6.

```
* Start Processing at Port 1  C:\SB\SBPORT1.PAR  Wed Oct 12 00:00:03 1994
* Data processing parameters used in collecting this file for Port 1
  100    -1     1
  101    -1     0
   .
   .                                                                        A
   .
  610    -1 OFF
  611    -1 D:\94SYS2\B
* Data processing parameters used in collecting this file for Port 2
  100    -1     2
  101    -1     0
   .                                                                        B
   .
   .
  610    -1 OFF
  611    -1 D:\94SYS2\B
* Fish Start   End Num. Start  Start  Range  Dist.  Dist.  Dist. Swim. Target Mx
* Num.  Ping  Ping Ech. Xcoord Ycoord meters X Dir  Y Dir  Z Dir Speed Streng Pt
  352    563    576   7  -0.19   0.12   3.16   0.37  -0.00  -0.34  0.47 -30.51  1
  353    890    911  17  -0.39  -0.23   4.90   0.46  -0.02  -0.25  1.14 -28.42  1   C
* End Sample Block for Port 1  C:\SB\SBPORT1.PAR  Wed Oct 12 00:02:00 1994
  354    264    286  14  -0.72  -0.51   7.38   1.27   0.29   0.08  1.35 -30.37  2
  355    985   1001  10  -0.33  -0.36   4.18   0.51   0.17   0.02  0.95 -27.10  2
* End Sample Block for Port 2  C:\SB\SBPORT2.PAR  Wed Oct 12 01:00:00 1994
* Stop Processing.  C:\SB\SBPORT1.PAR  Wed Oct 12 01:00:00 1994
```

Fig. 6: Example HTI FISH data file. A = Section listing the file creation time and date, the port on which data collection begins, and the parameter values used to collect data on port 1. B = Section listing parameter values used to collect data on port 2. C = Section listing data collected and times when port switching occurred.

The contents of the HTI FISH file are listed in Table 4.

Table 4: Contents of the HTI FISH data file.

Column Heading	Contents
Fish Num.	• Sequential fish number of the tracked target, since echosounder began collecting data.
Start Ping	• Sequential ping number on which the tracked target was first seen.
End Ping	• Sequential ping number on which the tracked target was last seen.
Num. Ech.	• Total number of echoes detected from the current tracked target.
Start Xcoord	• Initial horizontal position of the current tracked target in meters to the left or right of the vertical axis.
Start Ycoord	• Initial vertical position of the current tracked target in meters above or below the horizontal axis.
Range meters	• Range in meters of the current tracked target's initial position.
Dist. X Dir	• Total horizontal distance traveled by the current tracked target, in meters.
Dist. Y Dir	• Total vertical distance traveled by the current tracked target, in meters.
Dist Z Dir	• Total range traveled by the current tracked target, in meters.
Swim. Speed	• Mean swim speed of the tracked target in meters per second.
Target Streng	• Mean swim speed of the tracked target in dB.
Mx Pt	• Multiplexer port on which the target was tracked.

6) PBS FISH FILES.

PBS FISH files are not generated from HTI FISH files. Instead, they are a conversion of PBS ECHO files. This is done because it is much quicker to convert a PBS ECHO file to a FISH file than it is to convert and concatenate HTI FISH files. An example PBS FISH file is shown in Fig. 7.

jd	fish	startp	endp	stime	etime	nump	x	y
285	1	563	576	0.016194	0.016556	7	-0.1900	0.1200
285	2	890	911	0.025278	0.025861	17	-0.3900	-0.2300
285	3	264	286	0.040667	0.041278	14	-0.7200	-0.5100
285	4	985	1001	0.060694	0.061139	10	-0.3300	-0.3600

z	range	distx	disty	distz	speed	vert	horiz
3.1520	3.1600	0.3700	0.0000	-0.3403	0.4623	2.1803	-3.4496
4.8790	4.9000	0.6200	-0.0700	-0.1842	1.0541	-2.6990	-4.5702
7.3271	7.3800	1.2700	0.2900	0.1093	1.3452	-3.9816	-5.6122
4.1514	4.1800	0.4000	0.1400	0.0122	0.8859	-4.9562	-4.5450

phi	theta	scv	bpf	ts
4.0780	147.7244	0.5359	-5.7482	-30.5114
5.3018	210.5297	0.2551	-10.1784	-28.4194
6.8665	215.3112	0.2173	-18.3223	-30.3729
6.7094	227.4896	0.2454	-16.8153	-27.1000

Fig. 7: Example PBS FISH data file.

The contents of the PBS FISH file are listed in Table 5.

Table 5: Contents of the PBS FISH file.

Column Heading	Contents
jd	• "Julian Day", defined here as the number of days since January 1st.
fish	• Sequence number of the tracked target. Always starts at 1 for any given file.
startp	• Sequential ping number on which the tracked target was first detected.
endp	• Sequential ping number on which the tracked target was last detected.
stime	• Time in decimal hours, that the tracked target was first detected. A 24 hour clock starting at midnight is used.
etime	• Time in decimal hours, that the tracked target was last detected. A 24 hour clock starting at midnight is used.
nump	• Total number of pings detected from the tracked target.
x	• Initial horizontal position of the tracked target, in meters to the left or right of the vertical axis.
y	• Initial vertical position of the tracked target, in meters above or below the horizontal axis.
z	• Initial z coordinate (range projected onto the beam axis) of the tracked target, in meters from the face of the transducer.
range	• Initial range of the tracked target, in meters from the face of the transducer.
distx	• Total horizontal distance traveled by the tracked target, in meters.
disty	• Total vertical distance traveled by the tracked target, in meters.
distz	• Total z distance (range projected onto the beam axis) traveled by the tracked target, in meters.
speed	• Mean speed of the tracked target, in meters per second.
vert	• Initial vertical position of the tracked target, in degrees above or below the horizontal axis.
horiz	• Initial horizontal position of the tracked target, in degrees to the left or right of the vertical axis.
phi	• Initial spherical coordinate of target (see Fig. 3).
theta	• Initial spherical coordinate of target (see Fig. 3).
scv	• Peak output voltage summed over all 4 quadrants of the transducer.
bpf	• Beam pattern factor.
ts	• Mean target strength of the tracked target in dB.

Neither ***HAFU*** nor ***QTS*** use the HTI SUMMARY or HTI INTEGRATION files so they are not covered here. Refer to HTI documentation for details on these file types.

APPENDIX B - FILE NAMING CONVENTIONS

HAFU was originally designed to deal with the specific configuration that we use at our site at Qualark Creek, on the Fraser River. Thus, the program expects file names to be in a specific format. If you wish to use ***HAFU*** you must follow these naming conventions or else obtain a modified copy of ***HAFU*** from us. The naming conventions are as follows:

Table 1: File naming conventions used in *HAFU*.

File Type	Naming Convention	Extension
HTI RAW	SDDDHHMM	RAW
* Concatenated HTI RAW	SDDDHHMM	RW2
PBS RAW	PDDDHHMM	ALR
HTI ECHO	SDDDHHMM	ECH
PBS ECHO	PDDDHHMM	ALE
HTI FISH	SDDDHHMM	FSH
PBS FISH	PDDDHHMM	ALF
HTI SUMMARY	SDDDHHMM	SUM
HTI INTEGRATION	SDDDHHMM	INT
Compressed HTI Files	YYSDDD	ZIP

Where: **S** = A letter that refers to the echosounder system on which data were collected. (A = System 1; B = System 2).

P = A letter that refers to the port on which the data were collected. (A = Port 1; B = Port 2). Note that this can cause some confusion with the **S** convention used for HTI files, which refers to system number. In general you should keep data from each system in separate locations.

DDD = The day of the year on which the data were collected, beginning at 1 on January 1st of each year and ending on the last day of the year (usually 365). We define this as the *Julian Day*, although Julian Day is not technically defined this way.

HH = The hour that the data file began, based on a 24 hour clock starting at 00 at midnight of each day and ending at 24 at midnight on the next day.

MM = The minute that the data file began, from 00 to 59.

YY = The year that the data were collected on (e.g. 94 = 1994).

* After concatenation with the "Merge HTI RAW files" procedure of ***HAFU***.

APPENDIX C - INPUT CONVENTIONS USED IN *HAFU*

When entering data into ***HAFU***'s input window, the following conventions are always used.

- System number is entered as a **1** or a **2**, corresponding to the first or second echosounding system, respectively. This is an historical consequence of our use of two systems at Qualark.
- The year is entered as a 4 digit number, for example, **1995**.
- The day is entered as a 3 digit number beginning at 001 on January 1st of each year, and ending at 365 on non-leap years and 366 on leap years. We use the term *Julian Day* to describe this number, although this is not a technically correct definition of Julian Day.
- The time is entered as a 4 digit number representing hours and minutes, beginning at 0000 at midnight and ending at 2400.

APPENDIX D - MISCELLANEOUS *HAFU* UTILITIES

Two useful utilities can be found in the `\HAFU` program directory. These are designed to be run from the DOS command-line and convert a given *Julian Day* to a calendar date, and vice versa. The program to convert a Julian Day to a calendar date is called ***JD2DATE*** and the program to convert a calendar date to Julian Day is called ***DATE2JD***. They are used as follows:

```
JD2DATE <julian day> <year>
Where:       <julian day> = the Julian Day.
             <year> = the year.

e.g.

C:\> jd2date 201 1995
Julian Day 201, 1995 => July 20, 1995
```

```
DATE2JD <mm/dd/yy>
Where:       <mm/dd/yy> = the calendar date in the format month/day/year.

e.g.

C:\> date2jd 07/20/95
The Julian Day on 07/20/95 is: 201
```

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ACKNOWLEDGEMENTS

I thank the following people, in alphabetical order, for their many suggestions that helped in the design and implementation ***HAFU*** and ***QTS***.

George Cronkite, Hermann Enzenhoffer, Sam Johnston, Dr. Robert Kieser, and Dr. Tim Mulligan.